FEB 11 1929

"THE ENGINEER," JANUARY 25, 1929.

With METALLURGICAL SUPPLEMENT.

The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXLVII.—No. 3811] LONDON: FRIDAY EVENING, JANUARY 25, 1929 [PRICE WITH SUPPLEMENT ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 15th February, 1929, for LOW-PRESSURE HOT WATER HEATING at Bexhill-on-Sea Post Office, &c.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 784

Civil Engineering ASSISTANT REQUIRED, with good knowledge and experience in design of Steel Concrete and other Structures and Buildings. Ex-Service man preferred. Salary £140 per annum plus Civil Service bonus, at present about £74.—Applications, giving qualifications, full particulars of experience, and at least two recent testimonials, should be addressed to the SUPERINTENDING CIVIL ENGINEER, H.M. Dockyard, Portsmouth. 785

Crown Agents for the COLONIES. COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POST:—

M/906.—WATERWORKS ENGINEER REQUIRED by the GOVERNMENT of NIGERIA for the Public Works Department for two tours of 12 to 18 months' service, with possible extension. Salary £800, rising by annual increments of £40 to £920 a year; seniority allowance of £72 a year whilst on duty in the Colony. Free quarters, passages and liberal leave with full salary. Candidates, between 30 and 40 years of age, must possess a thorough knowledge of and experience in design and construction of Waterworks and in the investigation of water supplies in the Tropics and elsewhere. Must be Corporate Members of the Institution of Civil Engineers.

Apply at once by letter, stating age and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/906. 805

The High Commissioner for India REQUIRES an ASSISTANT ENGINEER INSPECTOR (Mechanical) for service in England. The post is on a non-pensionable basis and will be held in the first instance on probation for two years, during which period the services of the incumbent may be dispensed with at one month's notice. Thereafter service will be terminable by six months' notice on either side.

Salary £150, rising by annual increments to £300. Prospect of £310, rising by annual increments to £400 by promotion to Inspector. These salaries carry a variable cost-of-living bonus on the Civil Service scale. At present the bonus on £150 amounts to £76.

Candidates should be 28 to 35 years of age, have good technical and shop training and have held some position of responsibility. All-round rather than specialised experience is desirable. Preference given to A.M.I. Mech. E. or equivalent. Previous inspection experience not essential.

Applications, stating age, training and experience, and enclosing copies of recent testimonials, to be sent to the DIRECTOR-GENERAL, India Store Department, Belvedere-road, Lambeth, S.E. 1, not later than the 1st February, 1929. 698

In the High Court of Justice, Chancery Division. 1929, S. No. 01.
Mr. Justice Astbury.
In the Matter of SPENCER-BONECOURT LIMITED and Reduced
and
In the Matter of the COMPANIES (CONSOLIDATION) ACT, 1908.

Notice is Hereby Given that a PETITION presented to the High Court of Justice, Chancery Division, on the 9th January, 1929, for confirming the reduction of the capital of the above-named Company from £120,000 to £48,000 by cancelling paid-up capital which has been lost or is unrepresented by available assets is directed to be heard before Mr. Justice Astbury at the Royal Courts of Justice Strand London on Tuesday the 19th day of February 1929. Any person interested in the said Company whether as creditor or otherwise desiring to oppose the making of an Order for the reduction of the capital of the said Company under the above Act may appear at the time of hearing by himself or his counsel for that purpose. Such person is required to give two clear days' notice in writing of his intention to appear with the grounds of his objections to the undersigned the Solicitors of the Company. A copy of the petition will be furnished to any such person requiring the same by the undersigned on payment of the regulated charge for the same.

Dated the 23rd day of January, 1929.

NICHOLLS & CO., of 17, Farringdon-street, London, E.C. 4, Solicitors for the Company. 809

Sunderland Education Committee.

THE TECHNICAL COLLEGE.

DEPARTMENT OF MECHANICAL AND CIVIL ENGINEERING.

The Committee invite APPLICATIONS for the POSITION of HEAD of the MECHANICAL and CIVIL ENGINEERING DEPARTMENT. Applicants must possess an Honours Degree and have had good drawing-office and works experience.

The standard of the full-time day courses is that required for an Honours University Degree, and that of the part-time evening courses for Senior and Advanced Students from the marine engineering drawing-offices and works of the district desiring the Ordinary and Higher National Certificates of the Institution of Mechanical Engineers. Experience is all types of prime movers, steam and oil, is desirable.

Salary scale £600-£25-£700, less 5 per cent. for superannuation.

Application forms can be obtained from the undersigned and should be returned not later than Saturday, 9th February, 1929.

HERBERT REED, Chief Education Officer.

Education Offices, 15, John-street, Sunderland, 7th January, 1929. 667

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

The Metallurgist. THE ENGINEER, 25 - 1 - 29.

The Sutlej Valley Irrigation Scheme. (P. 93) THE ENGINEER, 25 - 1 - 29.

Retardation and Prevention of Oxidation No. II. (P. 92) (J. G. A. RHODIN). THE ENGINEER, 25 - 1 - 29.

Future Naval Construction. (P. 103) THE ENGINEER, 25 - 1 - 29.

The Mid-East England Electricity Supply. (P. 97) THE ENGINEER, 25 - 1 - 29.

Automatic Weighing Machines. (P. 90) THE ENGINEER, 25 - 1 - 29.

4000 B.H.P. Electric Locomotive for the Loetschberg Railway. (P. 97) THE ENGINEER, 25 - 1 - 29.

Modern Feed-Water Circuits. (P. 106) (J. G. WEIR). THE ENGINEER, 25 - 1 - 29.

Grinding Machines for Locomotive Parts. (P. 109) THE ENGINEER, 25 - 1 - 29.

An Early London Water Supply. (P. 110) (RHYS JENKINS). THE ENGINEER, 25 - 1 - 29.

INDEX TO ADVERTISEMENTS, PAGE 85.

PUBLIC NOTICES

The Institution of Mechanical ENGINEERS.

THOMAS HAWKSLEY LECTURE, 1929.

Professor A. S. EDDINGTON, M.A., D.Sc., LL.D., F.R.S., will deliver the above LECTURE on "ENGINEERING PRINCIPLES IN THE MACHINERY OF THE STARS," at the Institution, Storey's-gate, Westminster, on FRIDAY, 1st FEBRUARY, 1929, at 6 p.m.

VISITORS ARE INVITED.

The Lecture will be repeated in Sheffield on 13th February, in Leeds on 14th February, and in Cardiff on 11th April. 796

Borough of Basingstoke.

ELECTRICITY DEPARTMENT.

The Electricity Committee invite TENDERS for the SUPPLY, DELIVERY and ERECTION of:—

ONE HEAVY OIL ENGINE Direct Coupled with one 800-kW Three-phase, 50-Period ALTERNATOR.

Specifications, general conditions and form of Tender may be obtained from Mr. F. Swarbrick, Borough Electrical Engineer, Electricity Works, Basingstoke, on payment of a fee of One Guinea for each specification, which will be refunded on receipt of a bona fide Tender.

Extra copies may be obtained at Ten Shillings each, which sum will not be returnable.

Tenders, endorsed "Generating Plant," must be delivered to the undersigned not later than first post on Tuesday, January 29th, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

F. H. SMITH, LL.D., Town Clerk.

Municipal Buildings, Basingstoke, January 14th, 1929. 697

HERBERT MORRIS, Ltd., Loughborough, Leicestershire, REQUIRE the SERVICES of a MAN, about 30 years of age, to act as ASSISTANT to DEPARTMENTAL MANAGER. The person must have had an engineering training, and preferably some experience of Conveyor Work, but the chief qualities required are thoroughness, reliability, common sense and a capacity for shouldering responsibility. The post is a progressive one, both as regards status and remuneration. State age, give full particulars of experience, and salary required. Mark envelopes Dept. 34. 749 A

PUBLIC NOTICES

The Chadwick Trustees Invite APPLICATIONS for TWO TRAVELLING SCHOLARSHIPS of £400 a year each, tenable for one year, to be awarded next July; one Scholarship to be in SANITARY SCIENCE and the other in MUNICIPAL ENGINEERING.

The object of the Scholarships is to enable the holder to travel abroad to study, either generally or in some particular aspect, the methods adopted in different countries for the prevention of disease and the improvement of the public health, or the sanitary administration and engineering applied in urban or rural areas.

Candidates must be British subjects, between 25 and 30 years of age, who have graduated in a British University or who can produce evidence of attainments or of intellectual equipment proving them to be capable of methodical study and research.

A candidate prior to appointment must submit for the approval of the Trustees a scheme of study which he would be prepared to undertake and the itinerary he would propose to follow.

He would be required upon his election to undertake to conform to any plan approved by the Trustees, and from time to time and at the termination of his Scholarship to furnish reports to the Trustees on the results of his investigations in the course of his tour, which reports may be printed and published at the expense of the Trustees, who may require to retain the copyrights.

No other Scholarship shall be held nor any remunerative employment be undertaken during the tenancy of the Chadwick Travelling Scholarship without the express sanction of the Trustees.

The award of the Scholarships, and the acceptance or refusal of any application are entirely at the discretion of the Trustees, who may also, at their discretion, renew a Scholarship for a year.

Applications should be made by letter to the CLERK OF THE CHADWICK TRUSTEES at 204, Abbey House, Westminster, S.W. 1, stating name, qualifications, age and proposed object of study or research, accompanied by copies of testimonials and evidence of previous work undertaken or published. January, 1929. 737

ENGLISH FIRMS DESIRING First-class Energetic REPRESENTATION in Australia in engineering and associated lines, can procure same with firm of undoubted standing in Sydney. Excellent financial and selling record.—Write in first instance to Z.H. 251, care Deacon's Advertising Offices, Fenchurch-avenue, London, E.C. 3. 584 A

PUBLIC NOTICES

Borough of Bexhill.

TO MANUFACTURERS OF BORING PLANT.

The Corporation of Bexhill are prepared to receive TENDERS for PERCUSSIVE and ROTARY BORING PLANT capable of boring up to 10in. diameter.

Full particulars may be obtained on application to the Consulting Engineers, Messrs. H. Rofe and Son, MM. Inst. C.E., 208, Abbey House, 8, Victoria-street, Westminster, S.W. 1.

S. J. TAYLOR, Town Clerk.

Town Hall, Bexhill. 23rd January, 1929. 765

Government of the Commonwealth of Australia.

TENDER.

LEASE OF COCKATOO ISLAND DOCKYARD.

SHIPBUILDING AND ENGINEERING AND REPAIRING WORKS.

The Government of the Commonwealth of Australia is prepared to receive tenders for the Lease of Cockatoo Island Dockyard as a going concern for a term of 20 years with the option of renewal for a further term not exceeding 10 years.

The Dockyard is situated in the Harbour of Port Jackson, New South Wales, contiguous to the shipping centre of Sydney, and has an approximate area of 37 acres, with extensive deep-water frontage, including extensive wharf and fitting-out accommodation for vessels of the largest size, and is laid out with building slipways, shops, sheds, machines and all appliances and apparatus, tools, &c., necessary for the construction of naval ships and all types of passenger and cargo vessels, together with their Engines, Boilers, and Auxiliaries. The Works are capable of handling all types of General Engineering Work and of turning out all classes of Iron, Steel and Brass Castings, also Heavy and Light Forgings.

GRAVING DOCKS. There are two Graving Docks, the largest of which is 600ft. in length by 85ft., the smaller being 478ft. 5in. by 58ft. 8in. in width.

SHIPYARD. The layout of the Shipyard comprises Mould Loft, Shipwrights' Shop, Platers' Sheds, Forge, Plumbers' and Sheet Ironworkers', Joiners' Shop, Boat-building Shop, Sawmill, Rigging and Sail Lofts, Paint Shop and Galvanising Shops, all equipped with the latest and most modern machinery and appliances capable of dealing with the largest class of work, including all classes of overhaul and repairs.

ENGINE WORKS. The layout of the Engine Works comprises Pattern Shop, Iron, Steel and Brassfoundries, Fitting Shop, Machine Shop, Brass Finishing Shop, Boiler Shop, Coppersmiths' Shop, Testing Shop, Smithery, Electrical Workshop, Tool Room and Laboratory. The shops are fully equipped with first-class machinery and are capable of dealing with new construction and repairs to all types of machinery.

POWER HOUSE. The Power House is complete with Generating Plant supplying the whole of the electric power, light, compressed air and hydraulic pumps required by the Graving Docks and various shops and machinery at the Dockyard.

STORE. A large modern Bulk Store of three floors is available for housing all materials and fittings, and each workshop is equipped with a small issuing store. There are separate Stores for Timber and Iron.

CRANES AND TRAMWAYS. The Wharves, Workshops and Shipbuilding Slipways are well equipped with all necessary Cranes. The Shops, Yards, and the whole of the premises have also a complete system of tramways installed.

OFFICES AND RESIDENCES. Substantially built and well-furnished Offices for the use of Administrative Staff, Clerks, Estimators, Ship, Engine and Electrical Draughtsmen, Foremen, Timekeepers, is available. House accommodation is provided for the use of Manager, Superintendents, Accountant, Caretaker and Police, &c.

FLOATING CRAFT. Floating Craft consists of Floating Workshops, Tugs, Launches, Hopper Barge, Floating Oil Tank, Punts, Landing Stages, &c.

PARTICULARS, together with form of Tender, conditions of Tender, conditions of contract, together with schedule and plans of Dockyard, can be obtained by bona fide tenderers (principals only) at the office of the High Commissioner, Australia House, Strand, London, W.C. 2; the Prime Minister's Department, Canberra, F.C.T.; or at Cockatoo Island Dockyard, Sydney, N.S.W. A charge of £50 will be made per set of these documents, which sum will be refunded on their return accompanied by a bona fide Tender.

Sealed Tenders, endorsed "Tenders for Lease of Cockatoo Island Dockyard," and addressed to the Official Secretary, High Commissioner's Office, Australia House, Strand, London, W.C. 2; or to the Secretary, Prime Minister's Department, Canberra, F.C.T., Australia, to be lodged at the office of the High Commissioner, London, or of the Prime Minister, Canberra, F.C.T., respectively, not later than Twelve Noon on 30th March, 1929. The highest or any Tender not necessarily accepted.

J. G. McLAREN, Secretary, Prime Minister's Department, CANBERRA, F.C.T.

PUBLIC NOTICES (continued) Page 2.
SITUATIONS OPEN, Pages 2 and 4.
SITUATIONS WANTED, Page 4.
AUCTIONS, Page 86.
BUSINESSES and PREMISES (For Sale, etc.). Page 86.
MACHINERY, &c., WANTED, Page 86.
EDUCATIONAL, Page 4.
PATENTS, Page 4.
MISCELLANEOUS, Page 4.
AGENCIES, Page 4.
PARTNERSHIPS, Page 4.
FOR SALE, Pages 4, 6 and 86.
WORK WANTED, Page 86.
FOR HIRE, Page 86.

For Advertisement Rates see Leader Page.

PUBLIC NOTICES

Caterham Urban District Council.

MAIN DRAINAGE.

The Urban District Council of Caterham are prepared to receive TENDERS for the CONSTRUCTION, in the low-level area of the district, of about 20,000 YARDS of STONEWARE and CAST IRON SEWERS of 7in., 9in., and 12in. in diameter, together with all MANHOLES, VENTILATING SHAFTS and other APPURTENANT WORKS, in accordance with plans and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

Contractors desirous of tendering can obtain copies of the general conditions of contract, specification, bill of quantities and form of Tender from the offices of the Engineers, upon payment, by cheque only, of £5 (Five Pounds), which will be returned upon receipt of a bona fide Tender.

The drawings may be inspected at the offices of the Engineers or at the Surveyor's Department, Council Offices, Harestone Valley-road, Caterham.

Sealed Tenders, endorsed "Tender for Main Drainage," must be delivered to the undersigned at the Council Offices, Caterham, not later than Twelve Noon on Thursday, the 14th day of February, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

By Order,
P. E. DIMMOCK,
Clerk of the Council.

Council Offices,
Caterham, Surrey. 777

City of Nottingham.

The Works and Ways Committee are prepared to receive TENDERS for the SUPPLY of the undermentioned STORES and MATERIALS, the contracts to commence on the 1st April, 1929, and to terminate on the 31st March, 1930 :—

A.—Cement.
B.—Blue Lias Lime.
C.—Red Bricks.
D.—Blue Bricks.
E.—Timber.
F.—Stoneware Pipes, &c.
G.—Stoneware Pipes, &c. (patent joints).
H.—Iron Castings, Iron Gullies, &c.
I.—Yorkshire Flags, Kerb, &c.
J.—Granite Setts, Kerb and Broken Granite.
K.—Ironstone Slag, Chippings, &c.
L.—River Gravel.
M.—Concrete Sewer Tubes.
N.—Picks, Shovels, Scoops, &c.
O.—Ironmongery.
P.—Scavenging and other Brushes.
Q.—Limestone Chippings.
R.—Refined Tar.
S.—Pitch.
T.—Creosote Oil.
U.—Tarmacadam.

Forms of Tender may be obtained on applying to Mr. T. Wallis Gordon, City Engineer and Surveyor, Guildhall, Nottingham, on payment of a deposit of 5s. each, which will be returned on receipt of a bona fide Tender in accordance with the specifications, providing such Tender is not withdrawn and is delivered by the time stated below.

Patterns and samples may be inspected at the Eastcroft Depot, London-road, Nottingham.

The Committee will not consider any Tender except on the authorised form of Tender, which must be delivered to the undersigned, in the official envelope provided, on or before Tuesday, 19th February, 1929.

The lowest or any Tender will not necessarily be accepted, and Tenders will only be accepted from persons who conform to the conditions as regards paying the local standard rate of wages, &c., and to the working rules of the Nottingham District, applicable to the various trades.

By Order,
W. J. BOARD,
Town Clerk.

Guildhall, Nottingham,
14th January, 1929. 768

PUBLIC HEALTH ACT, 1875.

Littlehampton Urban District Council.

TO REINFORCED CONCRETE CONTRACTORS.

The Council, acting as the Water Authority for the said district, are prepared to receive TENDERS for the CONSTRUCTION of a REINFORCED CONCRETE RESERVOIR of 1,000,000 gallons capacity, together with sundry PIPE CONNECTIONS, METERS, and other ancillary WORKS.

Particulars and specification may be obtained at the offices of the Consulting Engineers, Messrs. Howard Humphreys and Sons, 28, Victoria-street, Westminster, on and from Tuesday, the 29th of January, 1929, until Friday, the 8th of February, 1929, between the hours of 10 a.m. and 4 p.m., upon payment of a deposit of Three Guineas, which deposit will be returned upon receipt of a bona fide Tender which is not subsequently withdrawn by the contractor.

The successful tenderer will be required to execute a contract and bond in a form to be prepared by the undersigned.

Tenders must be on the official form, each Tender in a sealed envelope, marked "Tender for Reservoir." Tenders must be accompanied by the general conditions and specification as issued by the Consulting Engineers.

Each Tender must be signed in the handwriting of the tenderer or his authorised agent.

The Council does not bind itself to accept the lowest or any Tender.

Tenders must reach the undersigned by 9 a.m. on Monday, the 25th of February, 1929.

Given under my hand the 22nd day of January, 1929.

A. SHELLEY,
Clerk to the Urban District Council of Littlehampton.

Town Offices,
Littlehampton, Sussex. 771

Metropolitan Water Board.

MAINS FOR THE IMPROVEMENT OF SUPPLY TO HENDON.

The Metropolitan Water Board invite TENDERS for the LAYING and JOINTING of the following CAST IRON MAINS, together with CONNECTIONS and contingent WORKS :—

2770 Lin. Yds. of 18in. dia. Main between Finchley-road and the North Circular Road ;
1875 Lin. Yds. of 18in. dia. Main between Brent-street and Holders Hill-road ;
1520 Lin. Yds. of 24in. dia. Main between the Vale, Hendon, and the North Circular Road ;
342 Lin. Yds. of 24in. dia. and 16in. dia. Main in Westbere-road and Mill-lane,

all in the Borough of Hampstead and the Urban District of Hendon, in the counties of London and Middlesex.

The drawings and contract documents may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 201).

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities may be obtained on and after Monday, 4th February, 1929, from the Chief Engineer, on production of an official receipt for the sum of £10, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Mains for the Improvement of Supply to Hendon," must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Monday, 25th February, 1929.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
22nd January, 1929. 775

PUBLIC NOTICES

South Indian Railway Company, Limited.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

ANTI-FRICTION METAL.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Anti-friction Metal," with the name of the firm tendering, must be left with the undersigned not later than Twelve Noon on Friday, the 8th February, 1929.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of the specification.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, Westminster, S.W. 1,
23rd January, 1929. 810

State Electricity Commission

OF VICTORIA, AUSTRALIA,
22-32, WILLIAM-STREET, MELBOURNE, AUSTRALIA.

TENDERS are hereby INVITED for the MANUFACTURE, TESTING, SUPPLY, DELIVERY, ERECTION complete, PUTTING INTO SERVICE, and MAINTENANCE of the following PLANT for the Yallourn Power Station Extensions, in accordance with Specification 29/7, comprising :—

SECTION 1.—Steam Turbo-generators.
SECTION 2.—Condensing Plant, including Circulating Water Pumps.
SECTION 3.—Evaporating, De-aerating and Feed-heating Plant, including Boiler Feed Pumps.

Copies of Tender form, specification, drawings, &c., will be available upon application to the Agent-General for Victoria, Victoria House, The Strand, London, England.

Charge, £3 3s. for set of three copies of Tender form, conditions of tendering, specification, contract conditions and drawings complete. This charge is returnable under certain conditions as specified in the general conditions of tendering. Extra copies £1 1s. each, not returnable.

Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 29th April, 1929.

A preliminary deposit of £100 shall be lodged with Tender.

The Commission does not bind itself to accept the lowest or any Tender.

R. LIDDELOW,
Secretary.

738

The Corporation of the County Borough of Londonderry

are prepared to receive TENDERS from competent persons for SUPPLYING and ERECTING MECHANICAL FILTRATION PLANT (pressure type) for 3,000,000 gallons per day at the Banagher Waterworks.

Conditions of contract, specification and plans may be obtained from the City Engineer, M. A. Robinson, M. Inst. C.E., M.I. Mech. E., Guildhall, Londonderry, and arrangements made for visiting the site of the works upon deposit of Five Pounds, which will be returned on the receipt of a bona fide Tender and return of all documents received.

Tenders, in sealed envelopes, endorsed "Banagher Filters," to be lodged at my office not later than Three o'clock in the afternoon of Wednesday, 20th February, 1929.

The Corporation do not bind themselves to accept the lowest or any of the Tenders.

F. HENRY MILLER,
Town Clerk.

Guildhall, Londonderry,
23rd January, 1929. 769

The Madras and Southern Mahratta Railway Company, Limited,

invite TENDERS for :—

26,316 FILES.

Tenders are due in on Tuesday, 12th February, 1929, by 2 p.m.

Tender form obtainable at address below ; fee One Guinea, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices :
25, Buckingham Palace-road,
Westminster, S.W. 1. 789

Tyne Improvement Commission

ELECTRIC TRAVELLING CRANE.

The Tyne Improvement Commissioners are prepared to receive TENDERS for ONE 14-TON PORTAL ELECTRIC TRAVELLING LEVEL LUFFING CRANE for the Riverside Quay at Albert Edward Dock, North Shields.

Copies of the form of Tender, conditions of contract and specification may be obtained on and after Monday, the 28th instant, on application to the undersigned, on payment of a deposit of £1 1s., which sum will be returned on receipt of a bona fide Tender.

Tenders in sealed envelopes, endorsed "Tender for Electric Crane" and addressed to "The Chairman, Tyne Improvement Commission, Newcastle-upon-Tyne," must be delivered at the undermentioned offices not later than Noon on Monday, the 18th February, 1929.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
ALBERT BLACKLOCK,
Secretary.

Tyne Improvement Commission Offices,
Bewick-street, Newcastle-upon-Tyne,
23rd January, 1929. 807

Wandsworth Union.

The Guardians of the above-named Union are prepared to invite TENDERS for the RE-ORGANISATION of the ENGINEERING PLANT at their Tooting Hospital, Church-lane, Tooting.

Firms wishing to Tender for Central Heating Plant, Central Kitchen, Water Softener Plant, and Builders' Work in connection with a new Engine-house, Kitchen Building and attendance on Engineers, in separate sections, to the plans and specifications now being prepared by the Guardians' Consulting Engineer, Mr. W. M. Binny, A.M.I.C.E., M. Cons. E., are requested to send their names to the Clerk with reference to similar recent work carried out by them at other Institutions.

Firms are requested in the first instance to examine at the offices of the Consulting Engineer, 39, Carlton-road, Putney, S.W. 15, a block plan showing the proposed extent of the work, after which a set of plans and specifications, when ready, will be provided to the firms selected to Tender, a deposit of £10 being required, which will be returned on receipt of a Tender properly filled in.

Applications to be allowed to Tender must be received not later than 2nd February, 1929.

By Order,
J. F. HARLOW,
Clerk to the Guardians.

Union Offices :
St. John's-hill, Wandsworth, S.W. 18.
18th January, 1929. 753

Mersey Docks and Harbour Board.

ENGINEERING ASSISTANT TO THE MARINE SURVEYOR AND WATER BAILIFF.

APPLICATIONS are INVITED for APPOINTMENT to the POST of ENGINEERING ASSISTANT to the Marine Surveyor and Water Bailiff.

Candidates must not be over 40 years of age ; must hold a Board of Trade First Class Certificate as an Engineer, and have had experience in ship construction and knowledge of motor machinery.

Salary £500 per annum. Applications, with copies of references and particulars of training and experience to be addressed to the undersigned not later than January 31st, 1929.

L. A. P. WARNER,
General Manager and Secretary.

Dock Office, Liverpool,
January 2, 1929. 617

PUBLIC NOTICES

Administrative County of London.

APPLICATIONS are INVITED for the POSITION of DISTRICT INSPECTOR of SCHOOLS in the Education Officer's Department.

SALARY.—£500 a year, rising by annual increments of £25 to £600 and thence by annual increments of £50 to a maximum of £800 a year, with a fluctuating temporary addition. At the present time the total commencing salary is £659.

DUTIES.—To conduct and assist in conducting the inspection of schools, colleges, and institutes within the area and to inspect and to advise upon instruction in technical subjects. Candidates should possess engineering or similar technical qualifications as well as teaching experience. Apply to the Education Officer (C.1.), The County Hall, Westminster Bridge, S.E. 1. Stamped addressed envelope necessary for form of application, to be returned not later than 11th February, 1929.

Canvassing disqualifies.

MONTAGU H. COX,
Clerk of the London County Council.

717

Bombay, Baroda and Central India Railway Co.

ASSISTANT SUPERINTENDENT OF STORES.

REQUIRED, for service in India, an ASSISTANT SUPERINTENDENT OF STORES, who should have had a good general and technical education and have been trained in the Locomotive Shops of a British Railway Company or in a Locomotive Builder's Works, and be fully qualified as a Mechanical Engineer. Preference will be given to one who has had Locomotive Stores experience.

COMMENCING SALARY.—According to age and qualifications, but not exceeding Rs. 700 per mensem. Increments according to the Company's usual scale.

TERMS.—A three years' agreement in the first instance, with first-class free passage to India and home again on satisfactory termination of service. Strict medical examination before appointment.

Applications (by letter only) must give full details of applicant's education, apprenticeship or pupilage, with particulars of departments worked in, and subsequent experience, showing dates in each case, and be addressed to the undersigned not later than 9th February, 1929.

S. G. S. YOUNG,
Secretary.

Offices : The White Mansion,
91, Petty France, Westminster, S.W. 1,
22nd January, 1929. 783

Shanghai Municipal Electricity Department.

STAFF APPOINTMENTS.

The Electricity Department of the Council REQUIRES the SERVICES of ONE SYSTEM CONTROL ENGINEER, TWO ASSISTANT SHIFT CHARGE ENGINEERS, and TWO DISTRIBUTION ENGINEERING ASSISTANTS.

(A) SYSTEM CONTROL ENGINEER.—The successful applicant would, whilst on shift, be responsible for directing all switching and operating on the distribution system. In order to keep familiar with the system he may be required to act for alternate periods as Distribution Engineering Assistant.

Applications will only be considered from those having the following qualifications :—

AGE.—Not exceeding 35 years.

TECHNICAL EDUCATION.—Equivalent to I.E.E. Examination for Associate Members.

PRACTICAL TRAINING.—Must have served an apprenticeship with some electrical engineering concern of good standing.

EXPERIENCE.—Must have had experience with maintenance and operation of large E.H.T. switchgear, transformers, relays and protective systems. Previous experience of control work advisable, but not essential.

The commencing salary will be Tls. 450 per month (ultimately rising to Tls. 630 per month).

(B) ASSISTANT SHIFT CHARGE ENGINEERS.—The duties attaching to these appointments are those connected with the operation of shifts in a large modern power station.

Applications will only be considered from those having the following qualifications :—

AGE.—Not to exceed 30 years and preferably single.

TECHNICAL EDUCATION AND ATTAINMENTS.—A knowledge of electrical and mechanical engineering such as will enable the candidates to pass the I.E.E. Examination for election as Associate Members.

PRACTICAL ENGINEERING TRAINING.—Preferably mechanical and electrical ; alternatively, mechanical only, in the works of a well-known engineering firm.

EXPERIENCE SUBSEQUENT TO TRAINING.—Preferably as Junior or Assistant Shift Engineers in large modern power stations, and having served in this capacity as immediate juniors to Charge Engineers in the control and scientific operation of power station plant from boiler room to control room. A knowledge of pulverised fuel working will be regarded as an advantage, but is not essential.

The commencing salary will be Tls. 350 per month, rising to Tls. 400 in three years, ultimately rising to a maximum of Tls. 580 per month.

(C) DISTRIBUTION ENGINEERING ASSISTANT.—Successful applicants would probably be employed in the Sub-station Section, which is responsible for the erection, operation and maintenance of all sub-station apparatus.

Applications will only be considered from those having the following qualifications :—

AGE.—Not exceeding 30 years.

TECHNICAL EDUCATION.—Equivalent to I.E.E. Examination for Associate Members.

PRACTICAL TRAINING.—Must have served an apprenticeship with some electrical firm of good standing, manufacturing heavy plant. Experience of manufacture and erection of H.T. switchgear, &c., is essential, and experience in the operation and maintenance of plant on a moderately large supply system would be considered an advantage.

The commencing salary will be Tls. 400 per month.

GENERAL.—Each appointee will be provided with free medical attention and will participate in the Council's superannuation fund and other benefits, which will be explained to candidates.

The present value of the Tael is approximately 2s. 7d.

The first engagement will in each case be for a period of three years, and free second-class passage out and home will be provided.

The maximum system load at present is 100,000 kW, the annual output is 530 million units and the generating plant capacity is 161,000 kW.

Applications should be submitted in writing only, giving full particulars as to age, education, training, subsequent experience and present position held, together with copies of testimonials, and forwarded to C. S. Taylor, M.I.E.E., M.A.I.E.E., Deputy Engineer-in-Chief and Manager, c/o Messrs. Preece, Cardew and Rider, 8, Queen Anne's-gate, London, S.W. 1, not later than Friday, the 1st February, 1929.

Envelopes should be marked with the letter "A," "B" or "C" corresponding to the appointment applied for.

T. H. U. ALDRIDGE,
M.I.E.E., M.I. Mech. E., Fel. A.I.E.E.,
Engineer-in-Chief and Manager.

16th January, 1929. 686

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a Competent MAN, to Take Charge of Running and Maintenance of Diesel Engines of total of 2000 H.P. in a factory in the South.—Address, giving particulars of experience and salary required, P5400, The Engineer Office. All replies will be treated as confidential. P5400 A

WANTED for an English Firm of Metal Merchants and Engineers in Calcutta, a TRAVELLING REPRESENTATIVE. Five years' agreement, must be unmarried, age 24 to 27. Commencing salary Rs. 500 per month.—Write, with copies of testimonials and photograph, if possible, to Z.Y. 391, c/o Deacon's Advertising Agency, Fenchurch-avenue, London. 773 A

SITUATIONS OPEN (continued)

WANTED, a WORKS MANAGER. State Fully education, experience, present and previous salaries, age, experience and knowledge of drawing and design, languages, and all qualifications, and when free to commence.—Address, 793, The Engineer Office. 793 A

WANTED for Shipbuilding Establishment in Hong Kong, ASSISTANT ENGINE WORKS MANAGER, with good training in Marine Engine Design and Construction. Age 28-30. State salary expected and give full particulars with copy testimonials.—Address, "HONG KONG," Wm. Porteous and Co., Advertising Agents, Glasgow. P5422 A

A PUBLIC COMPANY of Standing WISH to FIND a MAN of exceptional practical experience in Chemical and Industrial Engineering whose record constitutes convincing proof of his ability to undertake work of a very special nature.

He is required to investigate the practical application of a new process to a wide range of industries, and ability for research must be combined with an extensive and up-to-date knowledge of manufacturing plant and production methods.

Apply in the first instance, giving full details of qualifications, past experience and salary required, to Box No. B.M. 181, George Cuming, Ltd., 125, High Holborn, London, W.C. 1. 690 A

BOILER TEMPLATE MAKER REQUIRED for works in North London. Only men capable of setting out work from drawings and taking charge of the whole plating side of job need apply.—Address, stating experience, 795, The Engineer Office. 795 A

CENTRIFUGAL OIL SEPARATORS.—ENGINEER-DESIGNER, with actual practical running and testing experience, REQUIRED.

Address, stating age, experience, and remuneration expected, 806, The Engineer Office. 806 A

CONTRACTOR'S AGENT REQUIRED in Connection with the Construction of a Large Masonry Dam, Tunnel, &c., in the North of England.—Address, giving experience and references and stating salary required, P5404, The Engineer Office. P5404 A

ENGINEERS, Age Not to Exceed 33, THREE RE QUIRED, to Superintend Process Plant, Degreasing and Drying Plant. Fully conversant with Engineering and Departmental Management.—Address, with copies of recent testimonials, 815, The Engineer Office. 815 A

ENGINEER for London Office. Salary £500. Technical education essential. Practical knowledge of Power Transmission by Spur and Chain Gearing preferred. Electrical knowledge an advantage.—Address, P5414, The Engineer Office. P5414 A

ENGINEER (Heating and Ventilation). Practical and technologist Capable estimating, planning and laying-out. Able to secure maximum efficiency on fuel consumption.—Apply, letter only, full particulars, BRANSTON ARTIFICIAL SILK CO., Ltd., Burton-on-Trent. 742 A

EXPERIENCED BLAST-FURNACE MANAGER is REQUIRED for small up-to-date plant. Fullest particulars, including salary required, to be sent.—Address, 716, The Engineer Office. 716 A

JUNIOR CIVIL ENGINEERS REQUIRED for South American Railway, preferably with some experience of Railway Work. Starting salary £375 per annum, rising to £425 on three years' agreement. Free passage provided.—Write, giving full particulars education, training, experience, age, &c., with copies (only) of testimonials, to Box C. 8., c/o Davies, 95 Bishopsgate, E.C. 2. 741 A

LADY (20-30) REQUIRED for Translation, Abstracting Work, &c., in scientific research establishment in Birmingham. Really good knowledge of German and some scientific or engineering training essential.

Post offers opportunities of experience and possibly permanent employment in a field of work of growing importance.

Applications, giving full particulars of candidates' education and experience and stating age and salary required.

Address, 790, The Engineer Office. 790 A

LONDON ENGINEERING WORKS REQUIRE LONDON REPRESENTATIVE with connection and able to secure orders for all kinds of Heavy Steel Plate Work, electrically welded and riveted.—Write, stating age, experience, and terms in confidence, to Box 248, Sells' Advertising Offices, Fleet-street, E.C. 4. 779 A

MECHANICAL ENGINEER (39), Public School, full practical and commercial experience, REQUIRES responsible POST very urgently in works or commercial concern. London area preferred. No reasonable offer refused. Excellent references.—Write, Box W. 358, Willing's, 86, Strand, W.C. 2. 791 A

OPENING for YOUNG ENGINEER, Works Trained, with good General Engineering knowledge and real selling ability, as Assistant in old-established London Agency Business.

Write in first instance with full particulars, age, experience, and salary, to H. C. AMOS, M.I. Mech. E., 22, Martin-lane, E.C. 4. 812 A

PUBLICITY and ADVERTISING MANAGER REQUIRED by Hopkinsons, Ltd., Makers of Patent Safety Boiler Mountings and Valves, Huddersfield.—Address, stating age, experience and remuneration expected, to ROBERT A. HOPKINSON, Chairman and Managing Director, Hopkinsons, Ltd., Huddersfield. Envelopes to be marked in top left-hand corner "P.D." 751 A

RATE FIXER REQUIRED in Tool Room of Large Manufacturers, W. London. Must have practical experience on Jigs, Press Tools, &c.—Address full particulars, 803, The Engineer Office. 803 A

SALES ENGINEER WANTED for Glasgow, with a good knowledge of Pumps and Electric Machinery.—Address, stating experience and salary expected, 771, The Engineer Office. 771 A

SALESMAN-ENGINEER

WANTED for Great Britain by Leading Manufacturer of Heat Economy Instruments. Applicants only considered with experience in Boiler-house Practice, sound theoretical knowledge combustion problems and several years' salesmanship. General knowledge Electrical Engineering essential.—Address, giving full particulars and references, 623, The Engineer Office. 623 A

THE DIRECTORS of a Well-known and Old-established FIRM of PUMP MANUFACTURERS, having carried out works extensions for manufacture of Turbine Pumps, INVITE APPLICATIONS for POST of DESIGNING ENGINEER ; proposals will be considered only from persons who have held similar posts and are well equipped with the necessary technical and practical experience required for the design and economical production of this class of apparatus.

Please state age and salary required.

Applications to be endorsed "Centrifugal" and addressed 776, The Engineer Office.

Foreign publications please note. 776 A

WORKS MANAGER REQUIRED ; Must Be thoroughly conversant with Factory Management, Engineering and Process Plant, Degreasing, &c.; knowledge of chemistry a good factor. Only live men need apply.—Address application, together with copies of recent testimonials, 814, The Engineer Office. 814 A

For continuation of Small Advertisements see page 4.

A Seven-Day Journal

The Channel Tunnel.

ON Tuesday, in the House of Commons, the Prime Minister, pressed to provide time for an early discussion in Parliament on the Channel Tunnel scheme, declined to accede to the request, but stated that in his opinion the time was ripe for a comprehensive re-examination of the question. The Government, he said, was anxious that the proposed re-examination should, following the precedent set in 1924, be conducted in a non-party atmosphere, so that the decision of one Government might not be upset by a succeeding Government. It was also very desirable, he added, that the investigation should take into account not only considerations of Imperial defence but also the economic side of the scheme. While he indicated that the Committee of Imperial Defence would be consulted in the matter, he would give no indication as to what authority or body would be entrusted with the study of the economic aspects. It may perhaps be suggested, however, that the Civil Research Committee seems by its constitution to be particularly fitted for that task. In 1924, when the Labour Government rejected the scheme, it did so solely on the recommendation of the Committee of Imperial Defence. It is satisfactory to learn that on this occasion other voices are to be heard. The Channel Tunnel scheme, since its beginning, has been the sport of war influences. In 1802 Fox and Napoleon discussed a plan for a tunnel, but the recurrence of war between Great Britain and France ended the project. Sixty years ago, as our own columns of the time bear witness, great interest was again aroused in the scheme on both sides of the Channel. A final agreement had almost been reached when the outbreak of the Franco-Prussian War stopped all steps in the matter. In 1881 the scheme was revived and trial tunnels were driven 1¼ miles out from each coast. Then relations between this country and France became strained over the Egyptian question, and the situation was exploited by opponents of the tunnel to the extent of securing its abandonment.

Trolley Omnibuses.

AT a recent informal meeting of the Institution of Electrical Engineers, Major A. Jenkin opened a discussion on Trolley Omnibuses, and explained that the chief advantages of that type of vehicle over the petrol vehicle were better speed control, quicker acceleration, and lower mileage costs. The latest developments in chassis construction, driving mechanism, pole and shoe and motor and controller construction were described. Details were also given of the deviation indicator, which steers a path under the trolley wire and enables a vehicle to follow the correct course in the densest fog. Attention was also drawn to the fact that as a trolley omnibus is provided with rubber tires and does not run on earthed rails, such as those associated with tramway systems, good insulation is of the utmost importance, and that all current-carrying apparatus should be provided with the best possible protective gear, especially as regenerative braking was now common practice. The trolley omnibus, Major Jenkin explained, solved the problem of those who were faced with the enormous expense of relaying a worn track. There were only two places where trolley omnibuses had been tried and abandoned, namely, Leeds and Birmingham, the reason in the latter case being that the city had a large fleet of petrol vehicles, and it was desired to standardise one type.

The New German Airship.

PARTICULARS have been published in Germany of the projected airship which the Zeppelin Company is making preparations to build at Friedrichshafen. It is stated that the new vessel will have a length of about 780ft.—that is, the same as the length of the existing "Graf Zeppelin"—and a maximum diameter of about 125ft.—or some 25ft. more than the diameter of her immediate forerunner. The gas capacity will be about 5·3 million cubic feet, instead of about 3·7 million. The dimensions of the projected vessel are very similar to those of the two 5,000,000 cubic foot airships now being built in this country. The "R 101"—the Government vessel—has a length of 724ft. 3in. and a maximum diameter of 131ft. 8in. The "R 100"—the Airship Guarantee Company's vessel—has a length of 709ft. and a maximum diameter of 133ft. In keeping with Dr. Eckener's criticism of the "Graf Zeppelin," the new airship is to have its engine power greatly increased. Instead of five engines of 570 horse-power each, the "LZ 128" will be driven by either eight or ten engines of slightly less power. If ten engines are used they will be arranged in five gondolas, one in each gondola driving a pusher screw and the other a tractor screw. If eight engines are decided upon, the rear engine gondola will be replaced by a reserve steering car slung beneath the hull. The total horse-power will therefore lie between 4000 and 5000. In the "R 101" the five Beardmore heavy oil engines will give a total power of about 3200; while in the "R 100" the six Rolls-Royce petrol engines will develop an aggregate of about 4200 horse-power. The shed at Friedrichshafen in which the "LZ 127" or "Graf Zeppelin" was built, was barely sufficient to house that vessel. It is now, so we hear, being dismantled and reconstructed on a larger scale to accommodate the new airship. It is not yet known definitely when either of the new British vessels will be ready to take the air. We gather from recent information supplied to us, that the "R 101" is still some way off being completed. During the past week it has been stated in one quarter that the "R 100" will be ready for trial during the next few weeks, and in another quarter that the vessel will not be completed before September at the earliest.

The Causes and the Prevention of Fires Aboard Ships.

IN the newly published annual report of the Committee of the Liverpool Underwriters' Association, which is to be submitted to the annual general meeting of the members on Monday, January 28th, some interesting references are made to fires aboard ships, and possible means of preventing them. It is pointed out that, as shown by the Association's records, no less than 531 cases of fire occurred in steam and motor vessels during last year, against 517 in the preceding year. Of these fires 155 occurred in bunkers and 376 in cargoes. The experiments carried out by the Calcutta Marine Insurance Association on the spontaneous combustion of jute cargoes do not appear to have been conclusive, and it is thought that the majority of jute fires are likely to have had their origin in faulty electric wiring or smoking. During the year the problem of fires in bunkers has been investigated by the Fuel Research Board at the instigation of the Board of Trade. The report of the Board has yet to be issued, but it is believed that the view is held that comparatively few cases of fire arise from spontaneous combustion, the majority being caused either by local heating from steam pipes, radiation from boilers, and incorrect ventilation of spaces. The Committee's own investigations lead it to think that one of the principal causes of bunker fires is that the surplus fuel is allowed to be untouched in the bunkers over very long periods. When long voyages are made surplus coal is left in the bunkers, which may remain untouched even after several recoalings, and in this condition the coal naturally attains a more or less heated condition. The Committee expresses the opinion that if the Board of Trade regulations were to be made such as would require all bunkers to be completely cleared under supervision once every three months, then one of the principal causes of bunker fires would undoubtedly disappear.

A Suggested Iron and Steel Trades Inquiry.

A FORTNIGHT ago we recorded that the general secretary of the Iron and Steel Trades Confederation had addressed a letter to the Prime Minister dealing with the adverse conditions that have prevailed during the past seven years in the iron and steel industry, particularly in the heavy sections. The letter suggested that a Royal Commission or other competent committee should be appointed to make a full and impartial study of all the facts concerning the present position of the industry. It is understood that at its meeting on Monday this week the Cabinet considered the Federation's letter and decided to refer to a committee of Ministers the request for an inquiry, and that a reply to the letter can be expected in a few days. Last December the Federation obtained from the National Executive of the Labour Party a promise of support for its request for an inquiry. It must not, however, be forgotten that in 1925 the Civil Research Committee, to which the Government referred the question, reported against a proposal that an inquiry under the Safeguarding of Industry Act should be authorised in connection with the manufacture of iron and steel, the reason given being the wide interests that would be affected by the application of a safeguarding duty to the industry. The Confederation in its letter to Mr. Baldwin does not explicitly recommend the imposition of such a duty, but it seems clear that it would be willing to agree to that course if the proposed Royal Commission or Committee of Inquiry recommended it as desirable.

Profit-sharing in Productive Co-operative Societies.

WITH the publication by the Co-operative Productive Federation of its annual statistics, we are enabled to supplement the brief survey of profit-sharing and co-partnership results for the year 1927 which appeared in our issue of June 22nd, 1928. The thirty-nine societies included in the present return had at the end of 1927, 6058 employees and a wages bill for the year of £657,219. All but seven societies realised a surplus on their twelve months' trading, the net total of £128,846 being mainly disposed of by distributing £5889 to capital, £30,388 to labour, and £53,800 to purchasers, while a total of £5444 was paid to charitable and educational funds. A few minor allocations were also made, the greater part of the balance of the surplus being added to reserves or carried forward. The metal working and miscellaneous group of industries comprised six societies, which together had a membership of 1217 and a share and loan capital of £70,121. At the end of the year the group had 566 workpeople and had paid £63,384 in wages. Sales amounted to £221,779, the business leaving a surplus of £4501. Four of the six societies made a distribution to their employees. The East London Toy Factory, Ltd., with sixteen employees, realised a surplus of £419, of which £85, or 1s. in the pound on wages, was distributed to the workpeople. Chesham Builders, Ltd., gave a bonus of 9d. in the pound on wages to its twenty-eight employees, the distribution totalling £72 out of a surplus of £418. The Walsall Lock and Cart Gear, Ltd., out of a surplus of £2020, distributed to its 362 workpeople a total of £1167, or a bonus of 8d. in the pound on wages; while the Co-operative Sundries, Ltd., of Droylsden, Lancs., with a surplus of £1403, distributed £168, or 6d. in the pound, among 120 workpeople. The two societies making no distribution were the Alcester Needle Makers, Ltd., which had fourteen employees, a trade of £17,533, and a surplus of £181, and the Leicester Carriage Builders, Ltd., with twenty-six workpeople, a trade of £10,946, and a surplus of £60. The Federation's annual return, it may be recalled, refers only to those societies included within its organisation, and does not pretend to present a complete statement of the working of the profit-sharing principle in co-operative productive societies. We must, however, be satisfied with this limitation, for, since the suspension of the annual review made up to a few years ago by the Industrial Co-partnership Association, the Federation's figures are the only data published dealing with profit-sharing and co-partnership in this section of industry.

An Interesting Ship Repairing Operation.

A SHIP repairing operation of unusual interest was carried out quite recently in the Jarrow Dock of Palmer's Shipbuilding and Engineering Company, Limited, when the hull of the Ellerman steamship the "City of Lancaster" was straightened out and lengthened. The ship, which was built by Palmers in 1924, had an original length of 330ft., and is now 335ft. long. In a collision with an oil tanker, the "San Gerado," in the Thames, which occurred some weeks ago, the "City of Lancaster" was struck on her starboard side about 90ft. from her stern, the shell plates being forced inward for a depth of 5ft. The effect of this indentation was to shorten the length of the hull by nearly 10½in. and at the same time to offset the stern about 3ft. 3in. in a starboard direction. The steamer was patched up and safely towed to the Tyne. She was dry-docked in the Jarrow Dock, during which operation special provisions were made for supporting her hull with side shores and keel blocks. The hull was then burned through at the damaged section, so that the after part was separated from the remainder. Special launching ways were laid in order to enable the after part of the ship with the stern frame to be drawn away, so that the additional 5ft. of length could be built in. The operation was both difficult and delicate, but with the aid of 200-ton hydraulic jacks, the two parts of the hull were set apart and realigned in the short space of 40 minutes. Now that this essential work has been done, the necessary renewals to the shell plating, decks, frames, floors and keelsons are being made and new hatch coamings, &c., are being fitted. The repair is an extensive one, and some little time will elapse before the steamer is again ready for service.

The Society of Consulting Marine Engineers and Ship Surveyors.

THE announcement is made that Mr. J. Denholm Young has been nominated as the new President of the Society of Consulting Marine Engineers and Ship Surveyors, and that this nomination will be conferred at the annual meeting of the Society, which will be held in March. Mr. Denholm Young is well known in shipbuilding and marine engineering circles. He is a partner in the Liverpool and Newcastle firm of consulting marine engineers and naval architects, Messrs. Atkinson, Young and Robson. Mr. Young was educated at Edinburgh Academy, and graduated at Edinburgh University. He served his apprenticeship with Ramage and Ferguson, Ltd., of Leith, and in 1887 gained a Whitworth Scholarship. After some experience on the Clyde and at William Doxford and Sons, Ltd., of Sunderland, Mr. Young became, in 1892, chief draughtsman of the Sunderland works of the North-Eastern Marine Engineering Company, Ltd. Two years later Mr. Young left Sunderland in order to join his present firm. Since that time he has supervised the design, construction and operation of many types of steamers and motor vessels. He is a member of the Institution of Naval Architects and the North-East Coast Institution of Engineers and Shipbuilders, and is the author of several papers dealing with various aspects of ship construction and operations. One of his recent papers was that read in November last before the North-East Coast Institution of Engineers and Shipbuilders, which dealt with the losses in efficiency which occur in ships, and methods of overcoming them. A summary of this paper was given in THE ENGINEER of November 16th last.

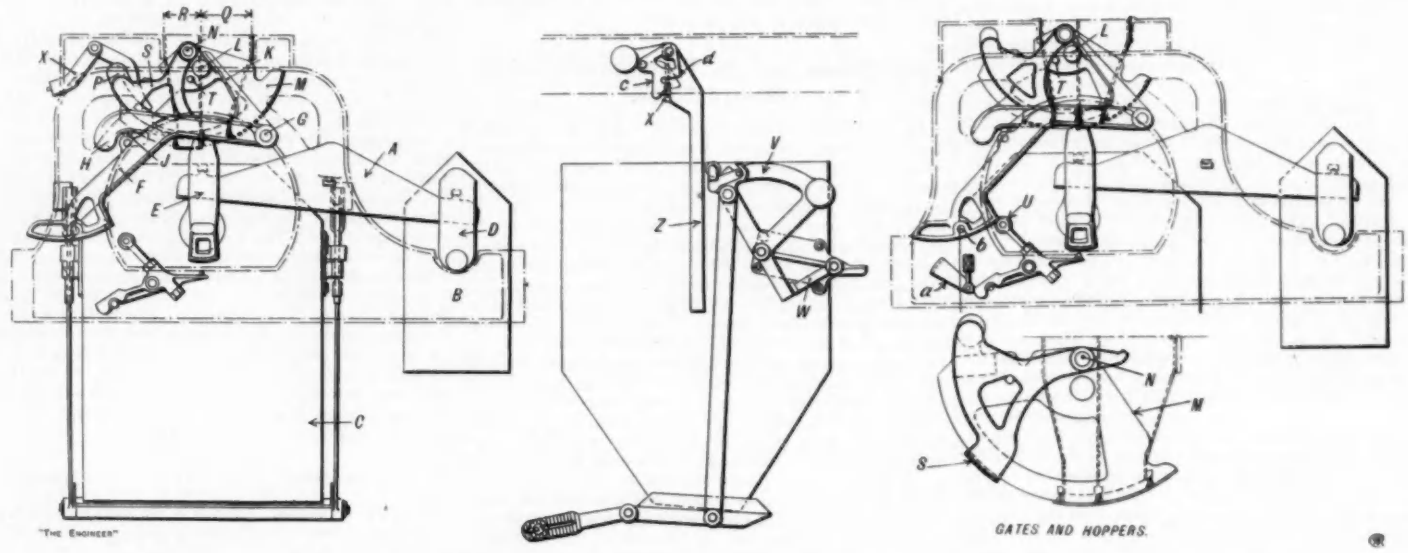
Automatic Weighing Machines.

No. I.

IN those industries in which large quantities of material such as coal or grain have to be handled the automatic weighing machine has become an almost indispensable unit for determining the amount of material received, operated upon, or dispatched. It has frequently been found that the installation of automatic weighing machines has resulted in the saving of considerable sums annually. The following description of a new series of automatic weighers made by Henry Simon, Ltd., of Manchester, should therefore prove of value to users or prospective users of machines of this description. In addition, the machines will be found to embody several principles and features of general interest from the point of view of most engineers, not the least important of which is the manner in which gravity is employed to the complete exclusion of springs. Messrs. Simon inform us that, as makers of all forms of handling and conveying machinery, they recently decided to manufacture themselves the automatic weighing equipment required in connection with such machinery and to abandon their previous practice of obtaining the weighers from outside sources. At the same time they decided to supply automatic weighing machines for general requirements apart from their own contracts. They are now making a wide range of automatic weighers at their Cheadle Heath works, and at the present moment have in hand more than fifty machines for public docks, railways, chemical works, flour mills, and so forth, for weighing such materials as coal, fine chemicals, minerals, grain, mill products, &c.

Before passing on to describe the mechanism of Messrs. Simon's "Reform" automatic weighers it is desirable that we should briefly mention some of the leading general features of the problems involved in the design of such machines. In broad terms an automatic weighing machine may be described as a device for damming up and releasing a flowing stream of material at regular intervals in such a way that the quantity discharged at each release is constant and equal to some pre-arranged amount. The energy required to operate the machine—or, at any rate, machines of the class to which Messrs. Simon's weighers belong—is derived entirely from the energy contained in the stream of material itself and is not supplemented from any outside source of supply. The weighing of the material is made against a dead-weight counterpoise carried at the end of a beam fulerumed at its mid-point and having at the other end the bucket into which the batches of material are deposited. Since the arms are equal, the counterpoise, when the beam is horizontal, is just equal to the weight of the bucket plus the weight of one complete batch. The material is discharged into the bucket from an overhead hopper, and while a batch is accumulating a door in the bottom of the bucket remains closed and locked. When the batch has been completed and before this door is opened to empty the bucket it is necessary to stop the flow from the overhead hopper in order that none of the material may escape unweighed through the bucket. According to the requirements of the user of the machine a fitment may be needed to record the number of times the bucket is filled and discharged, and, it may be, to print a ticket displaying the record. It may, too, be required to provide a residue weighing fitment, a device, that is to say, to weigh the last and probably incomplete batch of a run. Other fitments required may comprise means for testing the accuracy of the weighings at any time and for regulating the speed at which the machine works.

The question of the speed of working has an important influence on the design. In order to promote efficiency, the speed of discharge from the hopper into the bucket must be high. It is obvious, however, that a rapidly moving stream of material discharged into a weigh bucket will produce, by its momentum, an effect on the counterbalancing mechanism equivalent to a transient increase in the weight of the material in the bucket at any given instant. It is well known that if a chain is held vertically with its lower end just touching the pan of a spring balance and if the upper end is released the balance will momentarily register, at the instant when the top end of the chain reaches the pan, a force equal to three times the static weight of the chain. To overcome this momentum effect and at the same time to realise a reasonably high speed of working it is customary in automatic weighing machines to deliver the bulk of the batch at a high speed into the bucket and then to complete the batch by means of a slow speed or "dribble" feed. During the first or high-speed part of the flow into the bucket it is immaterial whether the bucket, beam and counterpoise are free or constrained. During the second or slow-speed part of the flow they must be completely free to balance about the central knife edges of the beam. It will be gathered that, in this respect, the designer of an automatic weighing machine has to reproduce very closely the conditions under which a shopkeeper uses—or at one time used—an old-fashioned set of hand scales. While he is pouring the bulk of the commodity into one of the pans he may allow both pans to rest on the counter, but to complete the weighment he must allow the pans complete freedom to equilibrate.



FIGS. 1 AND 2—ACTION OF HENRY SIMON'S "REFORM" AUTOMATIC WEIGHING MACHINE

The main principle on which Messrs. Simon's "Reform" automatic weigher operates can be understood by reference to Figs. 1, 2, and 3, which show the mechanism at three different stages in the cycle of movements. The beam A, Fig. 1, is in plan in the form of an H. It is supported at its middle by a pair of knife edges. Between one pair of its limbs it supports on knife edges the weight box B and between the other pair, also on knife edges, the bucket C. The weight box and bucket may be taken as balancing each other when both are empty. Let it now be supposed that weights equal to the required weighment are placed in the weight box. The beam as a result will tilt into the position shown in Fig. 1; that is to say, until the hangers D of the weight box meet stops formed in the machine frame for their reception. A cycle of events will then be started which will end with the discharge through the bottom of the bucket of a batch of material of the required weight.

When the beam tilts the top end of the hangers E, by which the bucket is suspended from the beam, strike the underside of a pair of levers or "falling arms" F pivoted one on each side of the machine at G.

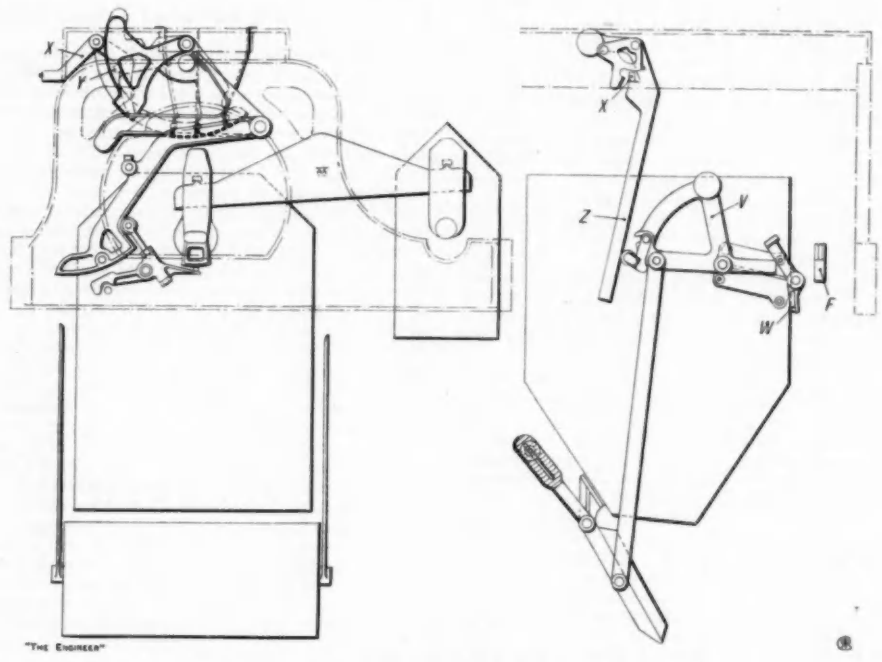


FIG. 3—THIRD STAGE OF WEIGHING ACTION

These arms are lifted up by the hangers, and in moving they also lift up a pair of other levers H or "feed gate closing levers," as they are called. These levers H are also pivoted at G and are in contact with the falling arms F at J. Further, they are provided with extension arms K against the ends of which rollers L press. These rollers are mounted on the sides of the main feed gate M. This gate is pivoted at N and a weight at P tends to make it turn in the anti-clockwise direction. When, therefore, the beam A tilts the two levers F H will be lifted and the main feed gate M will swing on its pivots into the position shown in Fig. 1. In this position the main feed gate leaves unobstructed the aperture at the foot of the main feed hopper Q, and as a consequence the grain

or other commodity can flow from that hopper into the bucket.

Adjoining the main feed hopper is a dribble feed hopper R. In the position shown in Fig. 1 the aperture at the foot of this dribble feed hopper is closed by a dribble feed gate S pivoted at N coaxially with the main feed gate and weighted to follow the movement of the main gate until it, the dribble gate, has closed the dribble feed aperture. The grain or other material is directed into the dribble feed hopper from above, but finding the aperture of that hopper closed, it accumulates until it overflows into the main feed hopper, whence it escapes into the bucket. In this setting the apparatus is said to be in the "full feed" position. It should be noted that in this position the weight at the end E of the beam includes the weight of the bucket, the weight of the grain that has passed into it and a downward force applied to the top of the bucket hangers by the falling levers F.

When a certain amount of grain—less than the full weighment—has passed from the main feed hopper into the bucket, the beam moves towards the horizontal position. Just before horizontality is attained, the parts assume the setting shown in Fig. 2. In reaching this setting, the falling arm has followed the descent of the bucket hanger and the feed gate closing lever has followed the descent of the falling arm. The extension of the feed gate closing lever acting on the roller L has moved the main feed gate about its pivot until it has closed the main feed aperture. The movement of the main feed gate has caused a pin T on its side to make contact with the dribble feed gate and to swing that gate back until it has opened the dribble feed aperture. The full feed from the main hopper has, therefore, been cut off and a small feed from the dribble hopper has taken its place.

When the setting shown in Fig. 2 is reached, the end of the falling arm makes contact with a trip trigger U, which now holds up the falling arm and relieves the bucket hanger of its weight. The beam in this condition is freed from extraneous constraint. The small flow of grain from the dribble hopper continues until the beam reaches the horizontal position, in which position the weight of grain in the bucket will be nominally equal to the weight of the counterpoise. When the beam reaches and swings through the horizontal position the lower end of the bucket hanger strikes the tail of the trip trigger and deprives the falling arm of the support of that trigger. As a result, the setting shown in Fig. 3 immediately supervenes. The falling arm descends suddenly and deprives the gate-closing lever of its support at J—Fig. 1—and as a consequence the extension of the gate-closing lever acting through the roller L causes the main feed gate to move round still farther, and close the dribble feed aperture. The dribble feed gate partakes of this movement of the main feed gate by virtue of its contact with the pin T—Fig. 2.

The bucket is now filled with the required weighment of grain, and the feed from the hoppers has been cut off. The emptying of the bucket is effected through a counterbalanced hinged door at its foot. During the earlier stages of the cycle the bucket door is held closed against the pressure of the grain inside the bucket by means of a link connecting the door with a quadrant-shaped piece—V, Fig. 1—hinged to the side of the bucket. A tail on this quadrant is engaged by a locking arm W, which is extended beyond its pivot into the path of the end of the falling arm F. Contact is made by the falling arm with the lock W, when the falling arm descends after being tripped by the movement of the beam through the horizontal position. As shown in Fig. 3, the knocking out of the lock W by the falling arm F allows the pressure of the grain to open the bucket door and pull round the quadrant. When the grain has been discharged, the counterweight on the door closes the door and swings the quadrant V upwards, thereby allowing the lock W to fall once again into the locking position. The rise of the bucket lifts the falling arm and allows the trip trigger U to fall back ready for the next cycle.

While the bucket is emptying the extension K of the feed gate closing lever presses against the roller L, and consequently the weight of the feed gate closing lever is available to hold the gates shut against the opening moment contributed by the counterweights at P. Reliance cannot, however, be placed on the closing lever holding the gates shut throughout the whole period during which the bucket is emptying. The beam and the bucket begin to rise some time before the bucket is empty, because, as the grain flows out, the weight at the bucket end of the beam diminishes, while that at the other end remains constant. In actual working the bucket is not completely emptied, and its door is not shut at the instant when the rising bucket hanger lifts the falling arm and the feed gate-closing lever, and removes the pressure of the extension K on the roller L. Were nothing done to prevent it, the gates would now open and grain would escape from the hopper and pass unweighed through the open bucket door. A positive lock is therefore provided, which holds the gates closed, independently of the force exerted on the roller L, throughout the whole of the emptying period. This lock is one of the several patented features in the design of the machine.

The lock provided consists of a latching lever X—Fig. 1—pivoted to the frame of the machine. One arm of this lever—the heavier arm—has a portion of its lower edge radiused from the centre N. Succeeding this portion is a bight, into which a pin Y—Fig. 3—on the side of the main feed gate slips, when that gate rises into the closed position. When this engagement occurs the heavy arm of the latch X falls and the light arm rises. The locking of the gates is, however, not yet complete, for the corner of the bight is radiused to an extent that makes the pin Y self-escaping from the bight under the force of the counterweights at P. The latch X, in order to provide an affective lock, has to be held in the position shown in Fig. 3 by means of something that will prevent the downward movement of the end of its lighter arm.

The means provided for this purpose comprises a pendulous locking lever Z, pivoted to the machine frame. When the bucket door opens and the quadrant V swings over, a roller on the quadrant engages with the lower end of the locking lever and moves it over to the left, as shown in Fig. 3. The light arm of the latch X is at this instant in the raised position and consequently an abutment on the locking lever Z can pass beneath that arm and so maintain it in the raised position. The feed gates are in this way positively locked in the closed position during the period in which the bucket door is open. As the bucket rises with its door open, the locking of the gates becomes, if anything, more secure. When the door closes and the quadrant V swings upward, the pendulous locking lever Z returns to the vertical position and deprives the latch X of its abutment support. The pin Y is therefore free to disengage itself from the bight in the latch, and in so doing lowers the end of the light arm of this latch against the vertical edge of the abutment on the locking lever

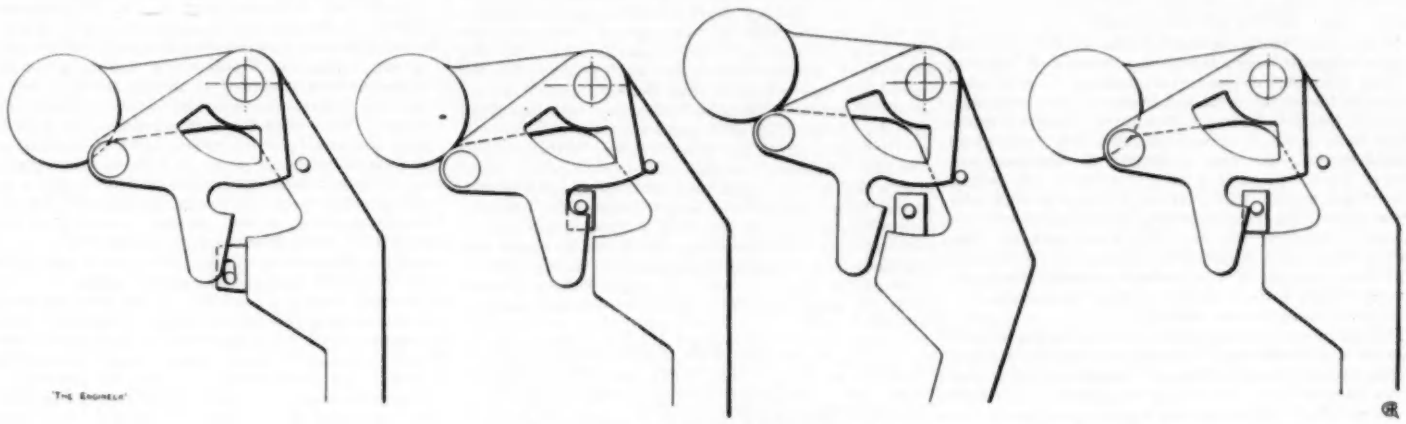


FIG. 4—ACTION OF AUXILIARY CATCH

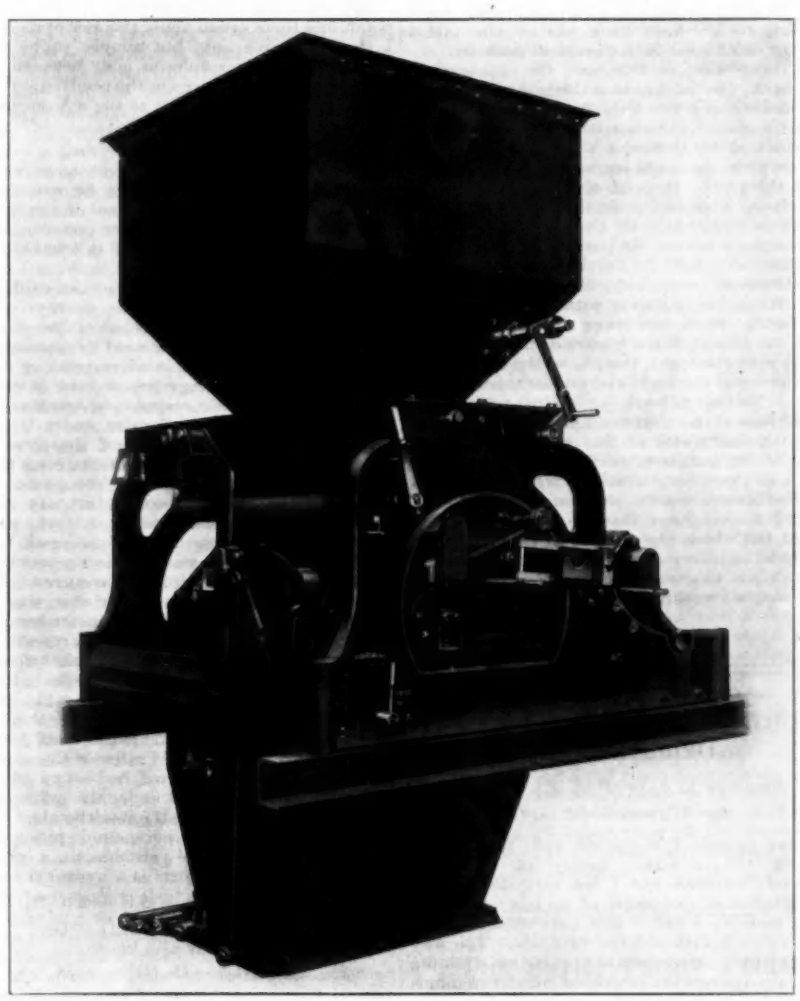


FIG. 5—"REFORM" AUTOMATIC GRAIN WEIGHER WITH GRAVITY FEED HOPPER

Z—see Fig. 1. The feed gates are now free to open. This arrangement not only secures the locking of the feed gates while the bucket door is open; it also prevents the bucket door from opening while the feed gates are open. This second effect arises from the fact that when the latch X is in the position shown in Fig. 1, with its face making contact with the vertical edge of the abutment on the lever Z, that lever cannot move to the left, and consequently the quadrant cannot swing over and the bucket door open.

Testing for Balance.

At any time while the machine is at work the truth of the weighment may be readily tested. When it is desired to make a test, the quadrant *a*—Fig. 2—hinged to the frame of the machine, is swung upwards, while the batch to be tested is running into the bucket. When the batch is completed and the descending bucket knocks out the trip trigger U, the quadrant catches a pin *b* projecting from the face of the falling arm. Thereby, the falling arm is held suspended, and is not allowed to descend far enough to knock out the bucket door lock W, Fig. 3. Consequently, the bucket, beam and weight box are left to equilibrate with the contents of the bucket retained inside it. The truth of the weighment is judged by means of a pointer attached to the beam.

The movement of the falling arm up to the instant when it is intercepted in the above described manner by the quadrant *a* is sufficient to result in the closing of the hopper outlets by the feed gates and to result in the catch X rising into its highest position. The fact, however, that the falling arm is intercepted before the bucket door lock W is knocked out, results in the quadrant V and the pendulous lever Z remaining in the positions shown in Fig. 1. Consequently, although the catch X has been raised, the abutment on the lever Z does not pass beneath it to lock the catch in the raised position during the testing of the weighment. The required positive locking of the feed gates during the test period is provided by an auxiliary catch *c*, Fig. 1. This catch is hinged coaxially with the lever Z and is weighted to press against a pin *d* on the side of Z. When the catch lever X rises, a pin on its end presses aside the auxiliary catch *c* until the pin engages in a bight in the auxiliary catch, which then swings back against the pin *d* and locks the catch lever X in the raised position.

On the completion of the test, the quadrant *a* is moved back, the falling arm descends to its full extent, knocking out the lock W, the bucket door opens and the grain is discharged. The accompanying movement of the quadrant V and lever Z causes the pin *d* to press the auxiliary catch out of engagement with the pin on the end of the catch lever X. The catch lever X passes on to the abutment of the lever Z and is maintained by that abutment in the raised or locking position. In passing on to the abutment the catch lever falls very slightly, not sufficiently to unlock the feed gates, but sufficiently to prevent the pin on its end re-engaging with the bight of the auxiliary catch when the lever Z returns to the vertical on the closing of the bucket door. Instead of re-engaging with the bight, the pin on the catch lever X strikes the toe of the bight and pushes the auxiliary catch back. The catch lever is now free to fall past the vertical face of the abutment, and, in descending, to unlock the feed gates in the normal way. As this action of the auxiliary catch is of some importance, and is not very easy to follow, we give in Fig. 4 four sketches illustrating the parts in successive positions. It will be recognised that the clue to the action is the slight fall which the catch lever experiences in passing off the auxiliary catch on to the abutment.

In Fig. 5 we illustrate a complete "Reform" automatic weigher working on the principles we have described.

(To be continued.)

On Retardation and Prevention of Oxidation.

By JOHN G. A. RHODIN, F.I.C.

No. II. *(conclusion).**

In my last article I abstained from any serious criticism of the peroxide theory of Messieurs Moureau and Dufraisse, but I felt very doubtful as to the existence of peroxides of metals or hydrocarbons in general, which would part with all their oxygen in contact with another peroxide. The way out lies in assuming, in the case of metals, that a minute film of the peroxide of the protected substance minus as much oxygen as it will give up, exists, forming a double layer with the peroxide of the catalyst, these two films doing all the work involved.

That peroxides themselves very often show catalytic properties was shown by Bredig in 1901. He found the limiting "dilutions" for decomposing hydrogen peroxide to be:—

For spongy platinum, 1 gramme molecule in 70 million litres.
For manganese peroxide, MnO_2, 1 gramme molecule in 10 million litres.
For cobalt peroxide, Co_2O_3, 1 gramme molecule in 2 million litres.
For copper peroxide, CuO, 1 gramme molecule in 1 million litres.
For lead peroxide, PbO_2, 1 gramme molecule in 0·1 million litre.

The solutions must be alkaline, as acidity causes inhibition of the reaction. Now, when I looked up the above in this connection, it struck me immediately that all these peroxides are useful depolarisers in known practical primary or secondary cells, and that for that purpose the order of excellence is just the reverse. Spongy platinum is not an exception, as with oxygen held in "adsorption" it is the depolarising element in Grove's gas battery. To this electrolytic aspect of the case I shall return. For the moment I may mention that Bredig found that the catalytic action of all these substances was paralysed (*sic*) by poisons in still smaller quantities, to wit, by hydrogen sulphide, prussic acid, iodine, iodine cyanide, bromine, aniline, hydroxylamine, amyl nitrite and nitrous acid, arsenic hydride, phosphorus and hydrogen phosphide, carbon monoxide, mercury bichloride, &c. &c. A good few of these anti-oxygenic catalysers are mentioned by Messieurs Moureau and Dufraisse in their Messel contribution. In the abstract of Bredig's paper at my disposal (*Svensk Kemisk Tidskrift*, 1901, pages 117–120) the following sentence occurs:—

"1.—If we assume with Haber that during the catalysis of H_2O_2 oxygen must be present, whether dissolved in, absorbed, or combined with the platinum, we might explain the poisonous action of reducing agents like H_2S, CO, H_2NOH, P, HCN, &c., thus, that they attack the oxygen attached to the platinum."

It seems to me that this, in conjunction with the experimental evidence of that time, is about as good a support of the peroxide theory as later work.

The question in the minds of my non-chemical readers will no doubt be, how peroxides are formed as a rule, and I may be excused for making a further brief departure into theoretical chemistry.

Peroxides in the narrow sense are characterised by at least one "semi-detached" atom of oxygen. This atom is forced to accompany the rest by application of energy—electric, thermal, or light energy.

Case 1.—The ordinary storage battery is a case in point, and there are so many theories of its action that I shall not give any, but simply suppose that we electrolyse dilute sulphuric acid between two lead electrodes and get oxygen at the positive and hydrogen at the negative pole. Part of the oxygen unites with the lead anode:

$$Pb + O_2 = PbO_2.$$

One of the oxygen atoms does, however, carry a charge with it and PbO_2 might be written PbO[O]. This substance is apparently one of the most stable of compounds, withstanding, for instance, the action of nitric acid perfectly, and still it is liable to give off oxygen and energy together.

Case II.—At dull red heat barium oxide takes up another atom of oxygen plus energy: BaO + O = BaO [O]. This was probably the first known synthetic peroxide, and it is used for making hydrogen peroxide. As an example of reversal of dissipation or amelioration of energy it is worthy of notice.

Case III.—Certain organic substances take up oxygen, forming true peroxides under the influence of light and moisture. One of the most startling cases occurred in my own experience some time about 1890. My first laboratory companion, a Mr. Charleville, at the municipal laboratory in Göthenburg, was drying some fatty extract, made with ethyl ether, and when he took the small basin with the residue from the oven and merely touched it with a glass rod a fearful explosion occurred. The small basin vanished, the stout copper oven was crumpled up out of recognition, its thermometer being shivered to minute fragments which flew all round. So great was their speed that a great number shot clean through Mr. Charleville's skin deeply into his flesh, to work out periodically for years afterwards. As they only weighed a few milligrammes each their velocity was almost incredible. The cause of all this commotion was proved later by Professor Cleve at Upsala, where a similar case occurred, to be a minute quantity of ethyl peroxide, formed under the influence of light and water by oxidation in the stock bottle. Chemically, the formation of this compound presupposes the formation of hydrogen peroxide as a preliminary, as the most explosive form is a hydroxyl compound:

$$(C_2H_5)_2O + HO\,.\,OH + \Delta E = 2\,(C_2H_5)\,[O.]OH.$$

(In this, HO . OH stand for $H_2O + O$).

A diethyl peroxide is also known:

$$(C_2H_5) - O\,.\,[O] - (C_2H_5).$$

Still, it lies in the nature of things that it is hardly easy to ascertain which is the culprit in case of accident, especially as both form together. The memory of the above incident made me take kindly to the peroxide theory in as far as knocking in internal combustion engines go, and its prevention by reducing agents, as the quantities acting need not be more than mere traces.

Apart from these modes of preparing peroxides, there is a fourth one by direct addition of the oxygen of the air, which was once of great industrial importance. I refer to the action of the Weldon "mud" in the Weldon chlorine process. In this process you peroxidise the same amount of manganese by blowing in air after precipitation with lime, time after time, till impurities or maybe some other kind of fatigue makes it inactive. It deserves to be noted that the Weldon mud must be alkaline to be active, thus again indicating the necessity of the presence of hydroxyl ions for direct oxidation to peroxide.

The number of peroxides known is very great; they occur in all the groups of the elements, and maybe all elements are able to attach charged oxygen atoms temporarily at least. Still, the cases of peroxides destroying one another are limited, at least in as far as we know, and in which way they cause polymerisation of certain organic compounds is as yet left as an open question by Messieurs Moureau and Dufraisse. Turning to the case of preservation of rubber, we find in their articles a number of observations of facts and tentative suggestions as to the nature of the action of oxygen. They lean towards a belief that a trace of oxide is formed, which causes polymerisation as in the case of styrol or acrolein. I can give them one fact from my own experience which supports their assumption, viz., rubber pipes through which electrolytic oxygen is passed without removal of ozone perish in a few minutes out of all proportion to the quantity of ozone, but only in the case of pure rubber. Still, although vulcanised rubber stands the action fairly well, it would be rather daring to state that the sulphur acts as an anti-oxygenic catalyser only, or to assume that vulcanised rubber does not oxidise. Furthermore, the pure rubber contains, according to their own statement, anti-oxygenic phenols from the smoke during the first curing process applied to the juice, and all the same it perishes more or less rapidly in the air. Synthetic rubber, which contains "no natural anti-oxygens, is particularly sensitive to the action of oxygen," say our authors, who also state that phenols are added up to 1 per cent. before vulcanisation to remedy this tendency. This is dangerous ground, in as far as it leaves the question open, whether the phenols act as antiseptics or anti-oxygens. It used to be the custom in some laboratories to store black rubber piping in brine, which excluded air and destroyed both oxidising and putrefactive bacteria. The drawback lay in a somewhat unpleasant discoloration, but the resilient nature of the rubber was preserved. There is also the astonishing preservation of the gutta-percha coverings of the Transatlantic cables after years in sea water, which contains enough oxygen to support millions of marine animals. Gutta-percha shows in the air a greater tendency to perish than rubber, and the action of the oxygen is enhanced by sunlight. If oxidation takes place with the aid of external energy, this supports the peroxide theory, and in the case of gutta-percha this apparently occurs. On the other hand, perished gutta-percha can be restored and made useful again by kneading it at 100 deg. Cent. with linseed oil, which would not be the case if Messieurs Moureau and Dufraisse were right in assuming further polymerisation in this class of substance.

Rubber is certainly not identical with gutta-percha, but the soluble part of the former at least is isomeric with the latter, though the actual molecular structure is unknown in both cases. Curiously enough, the oxidation products of gutta-percha have been analysed and indicate one or two atoms of oxygen as being added. The query is, whether linseed oil with its affinity for oxygen removes that oxygen by catalysis or by quantitative reaction. Would a small addition of linseed oil worked into new gutta-percha act as an anti-oxygenic catalyser and prevent its destruction in the first instance? To start practical experiments with gutta-percha as a preliminary to tackling rubber is advisable, as the former is a homogeneous substance, whereas the latter has a tubular, porous structure, which partly accounts for its properties. There is also the reason that even to-day the bulk of the available knowledge of the chemistry, &c., of rubber is kept secret by various manufacturers, whereas probably most information about gutta-percha is published. Another consideration is that vulcanised rubber of to-day hardly ever fails by perishing, but by wear and tear, whereas gutta-percha has lost its main field of usefulness, viz., as a terrestrial insulator, through perishing too easily. Otherwise, an insulator which can be softened in hot water to a plastic mass for jointing would be hard to beat. As it is, gutta-percha oxidises all too soon and loses its insulating power at the same time. There is no doubt that a means of preventing oxidation of gutta-percha, and its near relation balata, would be a very valuable discovery. But there is a complication which Messieurs Moureau and Dufraisse have not taken into consideration, viz., the substances in question are colloids and subject to structural changes which may upset the value of eventual discoveries or, on the other hand, enhance their value.

The history of rubber is by itself a case in point. Although Para rubber was brought to Europe by Condamine from his expedition to Brazil, 1736–1745, it was used for erasing purposes almost exclusively till one hundred years later, when the vulcanising process was invented. The reason was that the famous "gummi elasticum" only existed as such between 10 deg. and 30 deg. Cent.; below the lower limit it turned hard, and above the upper limit it softens and takes a "permanent set" under stress. These sudden changes are not uncommon with colloidal coagula, and they are also easily altered by additions in the most unexpected manner. It is not at all certain that Hancock, Goodyear or Lüdes-

* No. I. appeared January 18th.

dorff found the best possible in vulcanising with sulphur, nor is it likely that they expected what they got, nor that they got what they expected! The nearest approach to what they looked for, in as far as I can see, is so-called "patent rubber," from which the bulk of the sulphur has been removed, but no vulcanised rubber has got the elastic resilience so markedly present in pure rubber. For many purposes the sulphur impairs the use of vulcanised rubber, *e.g.*, it has the property of corroding copper and its alloys.

For this reason high-class insulated wire used to have and should have a layer of pure rubber nearest to the copper, though it might be, and often is, replaced by a cotton covering under the vulcanised rubber. Careful chemists should detach the vulcanised gas pipes from both Bunsens and nipples, when not used, to save the trouble of occasionally scraping them off with a knife, &c. &c. Hence, in spite of its usefulness, vulcanised rubber is not ideal, and a more innocuous substitute for sulphur would be received with acclamation in most quarters. The line to pursue experimentally is indicated by the effect of vulcanising on rubber, which consists in making the soluble liquid part of the rubber insoluble in carbon disulphide, &c., and like the insoluble structural part. This points towards starting with filtration of rubber solutions under pressure, evaporation of the solvent from the clear filtrate and experimenting according to Messieurs Moureau and Dufraisse, with any likely anti-oxygenic catalyser in one direction, and, in the other, with making additions which might solidify and render it insoluble in ordinary test tubes in an inert atmosphere. Combination of successful results in both directions should lead to useful results, probably of a quite unexpected nature. Here the theory is of no consequence, but the experimental method of determining the oxygen absorption or its cessation should be as good as any. The transplantation of eventual results to pure rubber might be easy, and it might not. As solidifying catalysers, small quantities of active Na_2O_2 or PbO_2 might be tried, or their opposites, like zinc dust, &c.; also the action of sunlight in each case.

As the probable financial gain cannot be very great, considering the satisfactory nature of motor tires and insulated cables, such laborious work can only be carried out by research associations, universities or individuals ready for great sacrifice of time and money. I feel that I cannot share the enthusiasm of Messieurs Moureau and Dufraisse, who in the section on rubber, in particular, go out of their way to find in every addition of reducing agents for protection against oxidation a support of their peroxide theory; they simply say on page 849 (*loc. cit.*), col. 1, end of section 3: "We think that this polymerisation is also due to a peroxide." Previously, they say that it is "their view" that ageing of rubber is due to polymerisation. They give no proof, but I have pointed out that the action of electrolytic oxygen is so rapid that only a sudden change of molecular structure can account for it. On the other hand, the behaviour of the closely related gutta-percha points to absorption of oxygen in quantity, and, furthermore, these substances are colloids and the alteration may concern larger structures than the molecules. I had also to suggest a method for making our authors' method of experimenting applicable to rubber, which they have omitted even to mention. With regard to the peroxide theory, I wish to put before the public—for the first time, as I believe—that Case II., referring to the formation of barium peroxide, shows that endothermic and exothermic are mere relativities in relation to the temperature of the surroundings, viz., $BaO + O \lesseqgtr BaO_2$ has the heat of reaction additive at ordinary temperatures and subtrative at 600 deg. Cent., where it becomes exothermic; above that temperature BaO cannot exist in air till the dissociation point is reached.

It is hence quite possible that with certain organic compounds like terpenes and rubber, this relativity is such that at ordinary temperature peroxides are formed by preference under the impetus given by a small exposure to light or electric stress. This would involve that some peroxides are exothermic to some degree and others endothermic, which would explain the mechanism of their interaction and mutual destruction in the cases of anti-oxygenic catalysis, according to our authors, probably better than the "activation increment." The equilibrium between mercury and oxygen at 320 deg. Cent., where the higher oxide is formed, is such an hesitating equilibrium, that a very small rise, viz., to 350 deg. Cent., reverses the action and a fall below 300 deg. Cent. prevents it taking place. This horrifying fact that the whole science of chemistry alters with the mean annual temperature in as far as combination heats and innumerable other "constants" are concerned, is refreshing to my mind, as it leaves room for explaining *outré* phenomena by taking merely possible relativities into consideration. I think this will suffice to show to the practical mind that the peroxide theory can be supported in a great many ways by possibilities arrived at by analogy, but also that the experimental work so far does not supply proofs of anything else than presence or absence of oxidation, and its comparative velocity.

In the case of the phenomena of "knocking" and anti-detonants, I feel inclined to admit that the peroxide theory passes the limit of possibility into the realm of probability. The difference between detonation and propellant explosion has always been a mystery with regard to cases where "safe" propellants have detonated accidentally. Even in the time of the old black gunpowder, it happened occasionally that safe-and-sound gun barrels were blown to bits by moderate charges. Through the investigations of Nobel we know that this can be brought about by sufficiently powerful percussion caps, but it happened with flint locks before that time. Curiously enough, I have personally had experience of the opposite, viz., on two or three occasions the firing of a Ballistite cartridge resulted in the percussion cap blowing the charge out of the gun without exploding the powder. Explosive gas mixtures are also erratic. I remember in one case, when determining methane by exploding with oxygen under diminished pressure, how the gas burette was blown to bits, though it had been used for the same purpose with the same mixture hundreds of times before. Failure to explode with the first spark is not very uncommon, even with a fairly fat spark, &c. &c.; as a matter of fact, this fact was observed by Davy. Many theories have been advanced to explain these phenomena, and of these the peroxide theory of Messieurs Moureau and Dufraisse appears to suit the observed facts the best.

They start by stating that "the sudden elevation of the pressure, which is produced by knocking, finds its explanation in the explosion of the peroxides." To the practical mind the first question is: What causes the formation of these peroxides? In other words, from whence is the potential energy necessary for the production of the endothermic compounds derived? I take it that during the compression stroke of the engine the mixture of air and vapour passes through a temperature where the peroxide forms like barium peroxide, the action being favoured by the high pressure as well. On the turn of the stroke a sudden cooling takes place, developing the endothermic nature of the peroxide and detonation follows. (It is simply unthinkable that direct additive combination of an element with a compound should yield another, which explodes at the same temperature and pressure. Nitrogen chloride is certainly explosive when it forms, but nitrogen and chlorine will not combine by direct addition, &c.) The cause of the extreme violence of the explosion of organic peroxides is not explained as yet, but it is astounding, as the energy quantities involved are very moderate. It is to be surmised that the velocity of the reaction is something approaching that of the discharge of a Leyden jar. Also that all the composing elements part company in a way totally different from the combination, evolution of heat, expansion, &c., in the case of ordinary explosives. Messieurs Moureau and Dufraisse also point out that the resulting gases are strongly ionised, *i.e.*, carry electric charges, and that carbon is deposited as such as a result of the detonation. They state furthermore that they have proved in other publications that peroxides do form in the liquid phase in internal combustion engines. There is no necessity for large quantities to form to give the knocking effect, as I have said before; besides, this would be fatal to any known material, but our authors have omitted to point out that an engine can start up knocking like fury and work itself silent without anti-detonants. Furthermore, there are thousands of fishing boats in Northern Europe using paraffin oil in their internal combustion engines, no doubt with interludes of knocking, but otherwise as silent as can be expected with a reciprocating engine. Accepting their theory, we can suppose that after a time the peroxides decompose again on the upstroke with rising temperature, which is so high, when explosion takes place, that peroxides cannot exist. Paraffin oil is supposed to be particularly inclined to cause knocking, still it is a practical proposition without additions. This is eminently an engineering question, and if the problem can be solved in the light of the peroxide theory by simple valve adjustment and attention to temperature there is little use for anti-knocking compounds. That this can be done I know, as I have seen and followed day by day experiments with tar, creosote, Russian oil residues, &c., in a certain oil engine, all causing terrible knocking till the proper adjustment was arrived at. As a chemist I am rather surprised that, when so many anti-knock compounds exist, such a vile substance as lead tetra-ethyl should have been selected. The discoverer of the organo-metallic compounds* had some assistants killed through the accidental breaking of a bottle filled with the, if possible even viler, arsenic compound kakodyl.

It may astonish non-chemical readers, but the discovery of this class of substance was of immense importance to theoretical organic chemistry, and from that point of view worthy of sacrifice; still, very few chemists have seen kakodyl or lead tetra-ethyl, and very few would like to handle either in quantity. However, Messieurs Moureau and Dufraisse state that substances proved to be anti-oxygenic catalysers in their apparatus are also anti-knocking compounds to some extent, but concentrations have evidently to be determined by experiments with engines. Now, this coming down to Bacon's sixth sense, experiment by trial and error, is what all working theories boil down to. The Messel Memorial contribution is propaganda for the experimental method, the actual small new issue, the peroxide theory, being almost crowded out by enumeration of substances, which can always be found in great numbers in the museums of a university laboratory, if it is old enough. The style of writing with references to predictions and inspirations by the authors themselves is no doubt strange to English readers, like the effusion with which the second article ends, but beneath the surface there is evidence of serious and valuable work done, though the theme has been kept too uniform to avoid monotony. A slight break occurs in the chapter on anti-detonants, which is by far the best part of the whole. Side issues like the phosphorescence of paraffin oil during distillation being due to oxygen absorption, &c., are interesting, but hardly novel; still, it provides a certain amount of logical coherence to the chapter. The treatment of the "dry" corrosion of metals in the beginning is, as I have said, disappointing, as it is the most important practical issue of the lot.

In all the various parts I have pointed out how hydroxyl or the anion of water seems to be a necessary agent in the reaction. Now, it was observed long ago by Basyer and Villiger that the hydroxyl in many compounds has an oxidising effect similar to that of ozone or hydrogen peroxide. The commonest example is hypochlorous acid, which is set free when bleaching powder is decomposed by an acid. A similar hydroxyl compound is formed by mixing one part of hydrogen peroxide solution with five parts of concentrated sulphuric acid. The same is the case with several organic peroxides studied by the above-named authors. As the hydroxyl ions in ordinary electrolysis are, so to speak, swamped by the negative ions of the dissolved salts, they are supposed to have nothing to do with the whole thing. Long and patient research has, however, shown that pure water is dissociated, or at least that a point can be arrived at when the hydroxyl ions outnumber the other anions. Any corrosion attributed to pure water vapour and oxygen must hence be attributed to an attack by these hydroxyl ions in the first place, and hence so-called direct oxidation is no doubt electrolytic in its origin. Furthermore, a coupling of two hydroxyl groups yielding hydrogen peroxide is quite natural, and, no doubt, occurs in the process of meadow bleaching under the influence of sunlight. From a theoretical point of view this seems to me to be the starting point to justify the peroxide theory of Messieurs Moureau and Dufraisse, as well as a means of adjusting the dynamics of catalytic auto-oxidation. In the first article I suggested a modified form of the French investigators' apparatus for trying the effect of water vapour by itself on metals with a view towards leading up to this short generalisation. We want facts and figures independent of accidental complications, and our authors had in no case excluded water vapour, to which I feel inclined to ascribe the possibility of oxidation taking place at all in many of their experiments. There is also another well-known fact, viz., that some peroxides reduce permanganate with evolution of oxygen, and others do not; in other words, some will fit in with the peroxide theory and some will not. Many practical facts are not pointed out, such as the marked chemical difference between American and Russian paraffin oils, the latter of which is unsaturated and more reactive in every way. Probably it also causes more knocking, as it is not popular with fishermen using motor boats. Engineers and manufacturers know that there is generally some scientific reason beneath the popularity of certain materials, and that advertisement will not perpetuate a market, even if it can create one. I have said above that knocking is not a permanent evil, but all the same it is desirable to do away with even a temporary disadvantage. That this can be done for ever by a ghastly addition like lead tetra-ethyl I take the liberty of doubting, as there are others. On the whole, the most promising fields of research indicated by the Messel contribution, round which these notes are compiled, concern corrosion of base metals, and perishing of pure rubber, gutta-percha and balata. I do not think for one moment that we need more for a year or two to go on with, but having made a great many suggestions, I may in a future article contribute some results of experiments of the kind suggested. I heartily agree with Messieurs Moureau and Dufraisse that all the issues touched by them are of the utmost importance to, not only civilisation, but to human existence.

* Sir Edw. Frankland.

The Sutlej Valley Project.

(Contributed).

IT has been my privilege as a civilian to be in touch with the most gigantic enterprise that the British engineers in the Punjab have yet undertaken. The previous achievements of the great Indian service of engineers have been wonderful enough. Before the British reached the Punjab, there were two channels from the Jumna and the Ravi, that had been excavated primarily for the amusements of monarchs, but even at the time of the Mutiny, the total irrigation from these and the little scratches of inundation canals along the banks of all the rivers did not amount to half a million acres. The British took the rivers systematically in hand, and by the aid of a succession

of weirs have bound one after another to their will. At the present day the canals irrigate 11 million acres in the Punjab and about ¾ million acres in the intermingled Punjab States. The last triumph of the engineers was big enough to strike the imagination. The triple project linked three rivers together as one for the purposes of the cultivators, and thus arranged to irrigate 2750 square miles out of 6250 square miles commanded. It had one additional merit in that it paved the way to the construction of the Sutlej Valley project, which commands 14,000 square miles and contemplates an annual irrigation of 8000 square miles.

The winter supply that the Sutlej brings down from the Himalayas is all used up in the Sirhind Canal, but the Beas, which has a very short independent run through the Punjab plains, sends a fresh quota to the Sutlej, while both rivers send down in the hot weather flood water towards the sea. At intervals from 1852 onwards proposals were made to use this water for the area between the Beas and the Ravi, and in 1897 Colonel Ottley prepared a Montgomery Canal scheme. The State of Bahawalpur, however, put in a claim for a share. This State has always had a number of inundation canals that took off some of the summer floods. It was fortunate that there were long minorities for three of its Rulers, during which it was ably served by British officers like Grey, Minchin, Ford and Barnes, who pushed on irrigation works until they were by no means negligible. Before a revised scheme could be examined the career of Lord Curzon in India had begun. It is customary in these days to scoff at him as the great examplar of the perfect bureaucrat, but India owes him much gratitude. The problem of the use of all the rivers was studied by the Irrigation Commission as a whole, the triple canal scheme came into existence, and the Beas-Sutlej water was reserved for future consideration.

Controversy as to its use went on indefinitely on paper. As had been already decided in the case of the Sirhind Canal, it was held by the Government of India that water should be made to cover as much as it could reasonably command, irrespective of the land being owned by the Punjab or by Indian States. The Bahawalpur State objected to this decision, which enabled a share to go to Bikanir, and argued that the owners of the two banks of the Sutlej, the Punjab and itself, should divide the water available. It was on stronger ground in pointing out what an enormous area it had that was capable of using the water, and in contesting scheme after scheme which did not satisfy its needs. It was also natural that it did not approve of a scheme for two long canals from a weir at Ferozepore, the Bahawalpur and Bikanir branches leading off from the British Left Bank Canal at the same place. The State obtained the assistance of Sir John Benton after his retirement, and with the aid of Mr. Davis, formerly a superintending engineer of the Punjab, had the matter thoroughly thrashed out. There was considerable controversy as to the amount of the Bahawalpur desert which would be capable of cultivation. I myself from knowledge of other areas have every sympathy with those who look upon the sandhills with the eye of faith as ultimately bound to flatten down into adjoining cultivation, and to disappear under the action of the wind, but others, who see wave of sand hill succeeding wave have every reason for pessimism. However, in the end Bahawalpur agreed that it would be content if water should be provided to command two million acres of its desert.

This stage had been reached when I was appointed Political Agent of the Bahawalpur State, and although the State authorities contested every other possible point with keenness, a settlement was in sight. The four weir scheme, which was ultimately worked out by Mr. W. H. Nicholson, under the guidance of Mr. Ives as chief engineer, was, after prolonged discussion, at which I was an interested spectator, finally approved by all the co-sharers in September, 1920. It had the merit that the canals dependent on the weirs were short, that no two co-sharers had to be joint owners in any one canal, and that the two States received water from different weirs and were not in any way brought into contact with each other. By such a number of weirs it became possible to capture every drop of water coming down the Sutlej for many months in the year instead of, as on the other rivers, being restricted to a supply about double of the winter flow. Moreover, the Chenab was also harnessed for the benefit of the Bahawalpur State. Although the Jhelum, Chenab and Ravi are already made to yield up water at two points each in their courses, there is an appreciable supply of seepage by the time that the Panjnad Junction of the Five Rivers is reached. This, in addition to the hot weather flow, has been brought into use.

Taken as a whole, the scheme is stupendous. From the four weirs twelve canals will lead away water for the benefit of nine million two hundred thousand acres. Such an area is better translated as one considerably larger than Belgium and nearly as large as Denmark. Of this, five million one hundred thousand acres will be cultivated annually. The biggest share of the new land belongs to Bahawalpur, which will be able to irrigate every year, in desert and riverine, three million acres out of five commanded by its six canals. The Punjab from five canals will water two million acres out of 3¾ million, and the Bikanir State by a long concrete lined channel 84 miles in length will bring down fluid wealth to 550,000 acres, of which 350,000 will be cropped annually.

The immensity of the enterprise can be gathered from the fact that, whereas all the irrigation works already in existence in the Punjab represent a capital expenditure of 23¼ crores, the Sutlej Valley project, constructed, of course, in days of high prices, will cost 23¾ crores, or £18,000,000. On the other hand, there is the pleasing fact that the prodigious works necessary to bring water to such a vast area of land will ultimately cost the co-sharers nothing at all, and indeed they should obtain from it capital from which to finance railways, roads, and other amenities. Each partner in this concern owns great tracts of Crown waste, which, valueless before the commencement of the scheme, are gradually bringing in large sums. Land without water is just mere space and nothing else, and the countries that are being irrigated are among the most arid and torrid of the world's surface. The annual rainfall of Bahawalpur averages 5in., and I have experienced a period of thirteen months in that State in which not a drop fell. On the other hand, once water is applied to the light soil, it answers in fertility at once.

The most striking part of the Sutlej Valley project is, no doubt, the fact that 3½ million acres of desert is to be put under crop as the years go on, but this is only part of the scheme. In the past a large area on both the Punjab and Bahawalpur sides of the river have been dependent on the summer floods. Agriculture under the conditions of the past was a gamble. The river might rise early or late, it might cease to flow prematurely or remain high well into the autumn, and it might jump about considerably within the same season. The crops might wither for want of water or be overflooded, and even the harvest on the threshing floor might be swept away by a sudden spate. The series of four weirs has been calculated to give security to an area of 5¾ million acres, and to change a somewhat sparse return on 1¼ million acres to a better result on three million acres. For this area water is only available in the summer months from April 1st to October 15th. The river indeed is not high enough in April and May to give a full supply to all the canals, and it sinks again at the end of the season, but on the average the canals can be made to run full for 155 days in the 198 of that period. It is considered that this will be sufficient for the area of three million acres, to give water at varying times for the sowing of the Kharif or summer harvest, to bring it to maturity, and to give the first sowing for the Rabi or winter crop, which will then mature on the moisture of the undersoil and such light rains as may fall from heaven.

The water in the Sutlej has been known to vary from an absolute minimum of 2057 cusecs to a maximum of 400,000 cusecs in a flood which came down while construction was in progress. It has been calculated that there will be a steady supply on the average of 6500 cusecs for the desert canals throughout the winter, that these can take double that quantity or 13,000 cusecs during the summer, and that the canals for the riverine can also in the summer take 25,000 cusecs. Thus, by holding up the water, as it flows, on the three weirs, the Sutlej can be kept dry until the flood exceeds 38,000 cusecs. In the future there will be dams within the hills which will hold up the surplus, so that it does not flow uselessly to the sea, but that day is not yet. For the southern portion of the Bahawalpur State 1032 cusecs are to be taken off from the Chenab for the desert and 9567 for the riverine from the supplies that reach the point where the five rivers meet.

With the sanction of all the authorities concerned, a start was made on this great system in October, 1922. An army of workers under Mr. Foy, chief engineer, was brought into being to tackle the four weirs, five perennial and seven non-perennial canals. The whole of the area was taken in hand by the Survey Department, divided into rectangles and levelled carefully. The designing of the canals down to the smallest water courses was fixed on paper, within the rectangles, as well as on the ground in accordance with scientific principles. A quarry for the whole project was established in the Nalagarh Hills, and railways built to connect it, and each of the weirs with the existing system. Lime and cement were arranged for on a great scale. In the river bed, plant worked by electricity was set up. Labourers arrived from far and near, and to supplement their activities huge drag line excavators found their way down the desert.

Actually, the Sulaimanke Weir was tackled first, and Mr. Nicholson was given the opportunity there to show that he could construct, as well as prepare a project on paper. Despite a record flood of 400,000 cusecs the work was completed and opened for irrigation in April, 1926. The Punjab has 900,000 acres of desert dependent on this weir, but the Bahawalpur State will have 1,150,000 acres commanded by its perennial canal. In addition, substantial areas of 266,000 and 561,000 acres are to be irrigated by the summer water. A large portion of the canals was ready to take water when the weir was opened, and progress has been constant since then. The railway line from Pakpattan to Lodhran was shifted slightly,

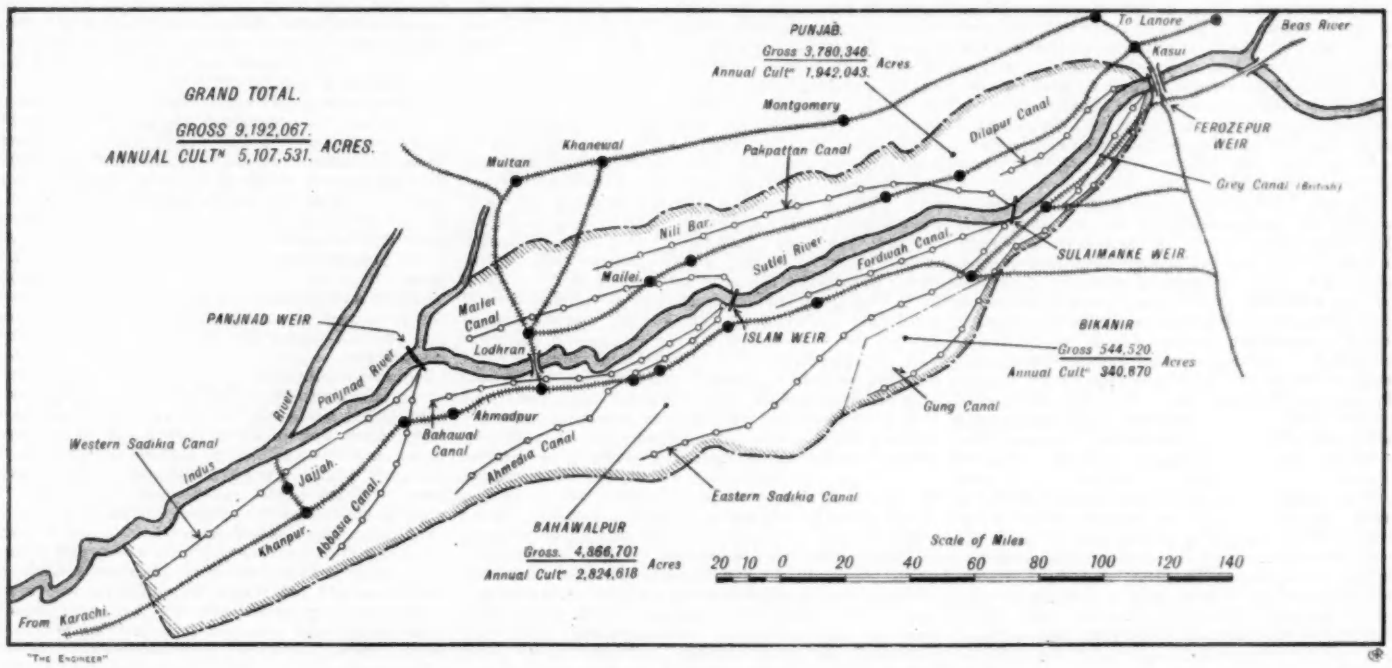


DIAGRAM ILLUSTRATING THE SUTLEJ VALLEY IRRIGATION PROJECT

to do better service for the new Punjab colony, while arrangements were made for 471 miles of metalled road, and 383 miles of unmetalled roads to be laid out in advance of the arrival of the Colonists. The existing line from Macleodganj to Samasatta on the Bahawalpur side runs on the margin between the perennial and non-perennial irrigation, but an extra length taking off from Bahawalnaggar into the most fertile tract has been put down. The Sulaimanke system is in itself gigantic, 2,875,000 acres are commanded, and 1,632,000 acres will be cultivated annually.

The Islam Weir, the third of the system, was started a year after the Sulaimanke, and was opened for irrigation by Lord Irwin, the Viceroy, on October 28th, 1927. On this the Punjab has only a non-perennial canal, but it is a big one commanding a million acres, and expecting to irrigate 530,000 acres annually. Bahawalpur has one non-perennial canal for 700,000 acres, but 582,000 acres dependent on a perennial canal, which will irrigate the desert. These canals run past the two capitals of the State, and over much of the country it is possible to drive a motor car for miles across a level plain.

The uppermost weir of all which has been constructed near the railway bridge of Ferozepore was also completed and opened in October, 1927. From this weir the Dipalpur Canal on the right bank and Grey Canal on the left will irrigate each year 600,000 and 250,000 acres respectively in Punjab territory with the aid of summer water only. The latter canal will be a substitute for a system for which the energy of one executive officer, Colonel Grey, was responsible. In addition, a perennial canal has been constructed on behalf of Bikanir, which runs for 84 miles before issuing a drop of water. This canal has been lined throughout with concrete, partly to prevent the constant flow of 2144 cusecs from waterlogging the Ferozepore district, and partly in order that the amount saved from absorption should be further available for the desert lands which stretch illimitable in this Rajput State. According to the original programme, 550,000 acres should have been commanded and 350,000 cultivated annually, but the State proposes to eke the water out somewhat further than originally intended. On the Ferozepore weir 2,100,000 acres will be commanded and 1,120,000 acres irrigated annually. Bikanir has also made special arrangements for a metre gauge railway through its new Colony that is linked up with two places on the existing Jodhpur-Bikanir line, and it has provided the materials for the cement lining of its own canal.

The weir across the Panjnad was started last, and is only in the initial stages. Bahawalpur alone is concerned with this. A small portion of the desert, amounting to 270,000 acres, will be irrigated from a perennial canal, but a vast area of land, totalling 1,600,000 acres now dependent on the spill water from the Chenab and Indus will obtain regular supplies all the hot weather from the Chenab alone, and will be protected down the whole length of the Indus frontage. It is of interest to know that while all the five rivers and the Indus itself run within beds of their own cutting through the Punjab plains, the Indus, once united to its tributaries, flows on its own silt above the surrounding country from Bahawalpur through Sind to the sea. In consequence, the great Bahawalpur Canal carrying 9567 cusecs from the Chenab, will run on the highest ground parallel to the Indus and will act as a double preventive against floods.

The arrangements for finance, for Colonists and for a hundred other things on behalf of the Bahawalpur State were naturally complex, and, in consequence, I had the opportunity as Revenue Minister of the State of seeing the wonderful work in progress. I made various journeys from the railway line to the dried up bed of the ancient river, the Hakra. For the 40 miles journey not a drop of potable water could be obtained. The Hakra itself contains solitary and deep wells, by which are placed strange old forts constructed in the past to check the depredations of raiders from Rajputana. Past the dead river, hills of sterile sand pile themselves up in great waves, but looking towards the Sutlej from the top of the tottering towers, it was possible to dream of visions of successive crops of wheat and cotton, and of golden yellow flowers gleaming above the deep emerald of oil-seed plants. I toured also in the riverine, and, while I had my share in the great shoots on the huge lakes formed by the spill of the rivers, I also saw the other drawbacks of uncontrolled irrigation, sour and greasy soil rank with salts forced up with the damp, and jungles of reeds and tamarisks grown up instead of crops.

The desert has gradually been yielding as the water comes steadily down it, and in the lower country each cultivator with regular supplies and the protection of strong embankments, is able to bring more and more of his lands under cultivation. The land hunger of the people of the Punjab, whetted as it has been by the fortunes won on the older canals, is sending out cultivators in search of new wealth. A few more years yet are needed before the full result of the engineers' efforts is shown upon the land, but it is estimated that at present prices there should be on this Sutlej Valley system alone an outturn of crops worth £25 million. Though the people of India are taking to a greater consumption of wheat, there will be a substantial addition to the foodstuffs of the world in general, and from the wharves of Karachix, already in the process of enlargement to meet the strain, cotton, oilseeds and other vital commodities will be despatched in increasing tonnage.

With three weirs completed, and water running down many canals in volume, of which several exceed 6½ times the flow of the Thames at Teddington, the time seems ripe for the expression of admiration for the wonderful organisation of the Indian irrigation engineers, which has enabled such things to come into being.

A series of views of the works referred to in the foregoing is reproduced on page 102

Institution of Mechanical Engineers.

LAST Friday's meeting of the Institution of Mechanical Engineers was devoted to the presentation and discussion of a paper by Mr. J. G. Weir, entitled "Modern Feed-water Circuits." The paper, a reprint of which will be found elsewhere in this issue, attracted a good audience, and provoked a considerable volume of interesting comment and opinion. Mr. Richard Allen, the President, seemed to express the general feeling of the meeting when he said that steam users were at present passing through a critical period of change, and that Mr. Weir's paper had come at the right moment.

Mr. S. B. Donkin, who opened the discussion, remarked that although the paper presented a comprehensive collection of feed-water circuits, those who studied it were left to find out for themselves the advantages and disadvantages of each. Every one of the nineteen schemes outlined by Mr. Weir failed in so far as they threw away a large volume of heat in the circulating water. Could not we produce something that would convert large quantities of low-grade heat into smaller quantities of high-grade heat? Some engineers and chemists were working on that problem, and he thought it possible that it might be solved by chemical means. He suggested that the Institution should initiate a research on means for avoiding the large loss of heat units in condenser circulating water. The results of such a research might well surpass the benefits to be derived from a fuel research programme, such as that being carried out by the Department of Scientific and Industrial Research.

Mr. H. L. Guy said that it was fitting that a descendant of Mr. Weir's great ancestor should read a paper on that evening's subject, for it was that ancestor who first conceived the idea of bleeding steam for feed-heating purposes. The lesson was, however, lost on the engineers of his generation, although Professor Elliot had examined the thermodynamics of the scheme and had shown that by carrying the bleeding process to the limit the Rankine cycle efficiency could be brought up level with that of the Carnot cycle. He liked Mr. Weir's suggested standard notation for power-house units, and thought that the idea might be commended to the attention of the International Electro-Technical Commission. Dealing with the circuit shown in Fig. 3 of the paper, the fundamental circuit with the addition of an open surge tank and a float-controlled boiler level, he recalled that it had at one time been proposed to stop the aeration of the water in the open surge tank by covering it with a film of oil. The proposal was ineffective, because it was found that air could penetrate the oil film with great ease and rapidity. Another proposal covered the fitting of a float valve to the surge tank, the duty of the valve being to control the admission of water from the tank to the condenser for de-aeration. A third plan consisted of converting the surge tank into a vacuum chamber. In order to secure complete de-aeration in that way it was found necessary to agitate the surface of the water in the tank by, for example, a small steam jet. In discussing feed heating by bled steam, Mr. Weir had said that in marine installations it was common practice to choose the bleeding point at such a position that the terminal difference between the temperature of the steam and the temperature of the feed at the outlet was about 20 deg. Fah. He, Mr. Guy, while admitting that such a difference might have been allowed in the past, did not think it would provide a satisfactory basis in the future. The relative advantage of a terminal temperature difference of 5 deg., as compared with one of 20 deg., would amount to a saving of 1 per cent. in the coal or oil consumption, and such a saving would pay the capital cost of more than the increased heating surface required to effect the change. He could not appreciate the technical advantages of the compound pressure boiler system—the "polytropic" system, illustrated in Figs. 19 and 20 of the paper. If we desired to use steam at any pressure we ought to generate it at that pressure and expand it down to the condenser pressure. The compound boiler schemes described by Mr. Weir appeared to him merely to be indicative of a transition period.

Engineer Vice-Admiral Sir Robert Dixon said that he was chiefly interested in marine feed-water circuits. The marine circuit formerly in common use was that shown in Fig. 6, with the de-aerator omitted. With tank boilers the corrosion which resulted from the presence of air in the feed water was not of prime importance, but with water-tube boilers steps had to be taken to prevent it. In the new 10,000-ton cruisers, a closed feed circuit had been specified, and he believed that that system would give satisfactory results. De-aerators might be found economical in merchant vessels, but in warships they were inapplicable. He had had experience of feed heating with the exhaust steam from auxiliaries, but had found that the feed temperature expected was not reached, because, perhaps, the efficiency of the auxiliaries was greater than had been estimated. He thought, therefore, that some form of feed heating by means of bled steam was necessary, although difficulties might been encountered in the application of that system in some vessels. Dealing with the evaporation of raw water for the make-up feed, he said that he had heard doubts expressed as to whether it was possible to distil from sea water a supply sufficiently fresh for use in water-tube boilers. During the past forty years the Navy had experienced practically no difficulty in obtaining from sea water a supply sufficiently fresh not only for use in water-tube boilers, but also for drinking purposes. He noted with satisfaction that low-pressure evaporators were provided in the new P. and O. liner "Viceroy of India." He noted with less than full satisfaction the combination of water-tube and tank boilers—Fig. 13—proposed by Mr. Johnson, of Canadian Pacific Steamships. Such a combination had been tried in the Navy twenty or so years ago, but had been found less satisfactory than a straight run of water-tube boilers. Discussing the mercury boiler, he remarked that after many years of experiment a small mercury plant was now running in the United States. The cost of mercury was, however, very high, and its properties were peculiar. He could not believe that the mercury boiler would be widely adopted in the near future.

Major William Gregson expressed his pleasure at the fact that Mr. Weir accepted the multi-stage boiler system with the flue gases traversing the units in series. It was extremely difficult to cater for the high-temperature gradient in a high-pressure boiler. In a two or three-stage boiler the heat gradient could be utilised effectively in each stage. In the high-temperature stages the transmission was mainly by radiation, whereas in the low-temperature stages it was mainly by actual contact. On the multi-stage principle the units could be those best adapted to meet the differing conditions. Mr. Weir had said that with a multi-stage boiler system an air preheater was not required, as the low-pressure boiler would reduce the flue gas temperature to the same level as in a normal air preheater. He (Major Gregson) maintained that the omission of a preheater was not always desirable. It was not difficult to introduce such a preheater, and its use had distinct advantages. He desired to know the cost of the mercury used in the mercury boiler referred to in the paper. It was evident, he concluded, that on the mercury side the circuit should be kept as simple as possible, because of the difficult properties possessed by the working substance.

Mr. W. H. Patchell liked Mr. Weir's symbols for power-house units, and said that the want of some such symbolisation was greatly felt during the labours of the Heat Engine Trials Committee. He noted that Mr. Weir described the de-aerator illustrated in Fig. 7 as having been first fitted in 1887, but he believed that the author's father, the late Mr. James Weir, patented his original de-aerator in 1871. He suggested that a bibliography setting forth what had already been done on the subject covered by the paper would be very useful, although it might have the effect of reducing the income of the Patent Office. It should not be forgotten when discussing the raising of steam pressures that an increase of pressure increased corrosion activity in boilers. He did not quite agree with the author's remark that the fitting of an economiser enabled the number of bled steam heaters used to be reduced. He thought the tendency went in the opposite direction. The various feed-heating cycles described in the paper had, like alternating-current electricity, proved a godsend to the professors of engineering, but he was not always convinced of their practical advantage. The reference to Ruth's steam accumulator brought before his eyes the late Mr. Druitt Halpin sitting in his favourite corner at past meetings of the Institution. Mr. Halpin was the first thermal storage authority. All that had been done since his day had been built up on his work. The system had been amplified, but had not been greatly changed. He challenged Mr. Weir's use of the word "polytropic," as applicable to a multi-pressure boiler system. According to the dictionary the word meant versatile. Had a Scotsman for once dropped an "h"? Did Mr. Weir mean to write "polytrophic," which, so said the dictionary again, meant nutrious or very full of meat? He did not know of any multi-stage boiler in this country, but several were now in use on the Continent. Turning to the mercury boiler, Mr. Patchell called the attention of the meeting to an alternative to mercury for use in binary fluid boilers, namely, a liquid known as di-phenol oxide. This substance, a sample of which he exhibited, smelt very strongly, and was in commercial use as a base in the manufacturing of geranium scents. Referring to Mr. Guy's remarks concerning Professor Elliot and Mr. Weir's father, he said that Lord Kelvin had disagreed with Professor

Elliot's conclusions, and had pronounced against the scheme. It was not the only instance in which an opinion of Lord Kelvin's had been shown by experience to be wrong.

Mr. Thomas Clarkson stated that he was impressed with the merits of Mr. Johnson's system of combined high-pressure water-tube boilers and medium-pressure tank boilers. The scheme resulted in all the salts being deposited in the tank boiler, a less harmful place for their deposition than in the water-tube boiler.

Mr. I. V. Robinson said that there was a great need for a uniform system of standard symbols for power-house plant. The disadvantages of not having such a system were particularly noticeable when one was studying descriptions of plant or the results of an investigation in a foreign language with which one was not perfectly familiar. He had recently seen a table prepared in Germany giving 80 to 100 symbols of a simple kind covering all the apparatus used in a power-house. He had made inquiries and found that while there was not general agreement in the use of these symbols, they were being considered as a basis for standardisation. He suggested that the British Engineering Standards Association should be asked to draw up a complete schedule of power station symbols. It was obvious that electrical as well as mechanical symbols should be included in the scheme. He agreed with Mr. Guy that the compounding of boilers could only be regarded as a temporary procedure. The system was properly only an expedient to familiarise the management and staff with high pressures. On the other hand, however, he had to note that in the United States the use of compounding was being perpetuated for its own merits.

Mr. J. G. Weir, replying briefly to the discussion, expressed his appreciation of Mr. Guy's and Mr. Patchell's references to his father's work. His father, he said, was always more interested in the thermodynamics and underlying principles of his ideas than in their practical application. Engineers in those days could not, however, see how it could be advantageous to withdraw steam from an engine before it had completed its full normal amount of work in the circuit. His father had found it impossible to conduct business commercially and adhere to the thermodynamic principles which he knew to be right. Continuing, he defended the use of the word "polytropic," and maintained that it meant "many pressured." The standardisation of symbols by the B.E.S.A. was, he thought, a matter of urgency. Such standardisation would facilitate and improve the exchange of ideas.

Record Efficiency of a Turbo-Alternator.

AN efficiency, which, we believe, constitutes a record for steam plant, has recently been attained by a turbo-alternator supplied by C. A. Parsons and Co., Ltd., of Newcastle-on-Tyne, to the White Bay power station of the New South Wales Government Railways. The unit, which is illustrated in Figs. 1 and 2, comprises a two-cylinder turbine direct coupled to a three-phase alternator having a maximum continuous rating of 20,000 kW at 11,000 volts and 80 per cent. power factor, the speed being 3000 revolutions per minute. The most economical load of the machine is 16,000 kW, at which output the thermal efficiency measured from the stop valve, as determined on the official trials of the machine, was no less than 29 per cent. The turbine itself, as will be seen from the details of the test reproduced in the table below, had the extremely good efficiency ratio of 86·2 per cent. The plant was designed to work under the conditions prevailing in the White Bay power station, namely, with steam at 260 lb. per square inch gauge pressure and 635 deg. Fah. temperature at the stop valve. The vacuum was to be 28·5in. Hg. with a 30in. barometer. The turbine was further designed for steam extraction, so that the condensate could be heated regeneratively to 180 deg. Fah.

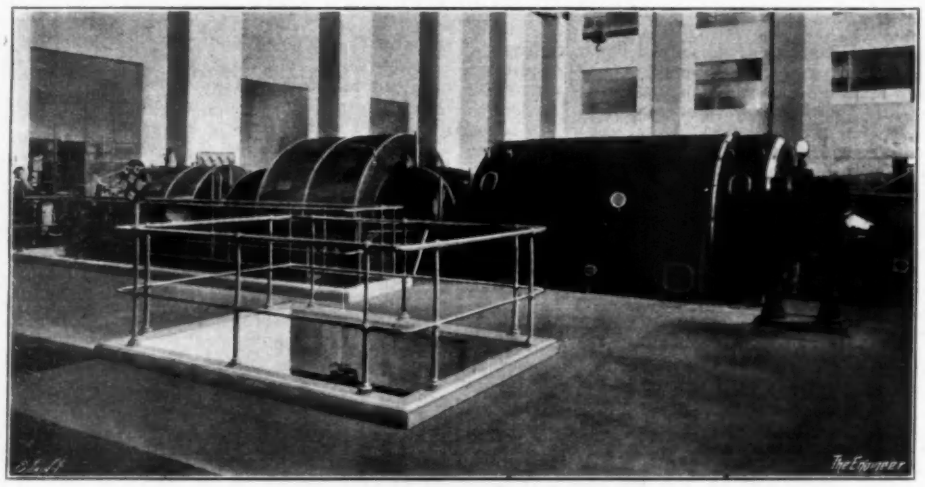


FIG. 1—20,000-kW PARSONS TURBO-ALTERNATOR

Test Results on a 20,000-kW Parsons Turbo-alternator at White Bay Power Stations, N.S.W. Government Railways.—Date of Test, July 6th, 1928.

(1) Steam pressure at stop valve, lb. gauge	264·7
(2) Steam temperature at stop valve, deg. Fah.	626·4
(3) Vacuum at turbine exhaust, in. Hg. (bar. = 30in.)	28·535
(4) Feed water temperature, deg. Fah.	180
(5) Total output per hour, kW	16,047
(6) Power consumption by auxiliaries, kW	251
(7) Net output, kW	15,796
(8) Steam consumption, total, lb. per hour	161,092
(9) Steam consumed by auxiliaries, lb. per hour	1,600
(10) Net steam consumption per hour, lb. per hour	159,492
(11) Steam consumption from (7) and (8), lb. per kWh	10·198
(12) Steam consumption from (11), corrected to specified conditions of steam and vacuum, including all auxiliaries, lb. per hour	10·12
(13) Steam consumption from (5) and (10), excluding auxiliaries, lb. per kWh	9·94
(14) Steam consumption from (13), excluding auxiliaries, corrected to specified conditions of steam and vacuum, lb. per kWh	9·86
(15) Heat consumption from (14), exclusive of auxiliaries, B.Th.U. per kWh	11,753
(16) Thermal efficiency, stop valve conditions, per cent.	29
(17) Efficiency ratio at turbine coupling, per cent.	86·2

With a comparatively low steam pressure and a very moderate steam temperature and vacuum a consumption of 10·12 lb. per kWh, including auxiliary steam, or 9·86 lb. per kWh without auxiliaries, is certainly a very fine result. An absolutely perfect turbine, with no losses of any kind working on the ideal Carnot cycle between the same temperatures as the White Bay turbine and coupled to an equally perfect generator, would require 6895 B.Th.U. per kWh. That, therefore, represents the theoretical limit of efficiency. The White Bay unit, working, of course, on a cycle inferior to the ideal one of Carnot and saddled with the inevitable losses of an actual turbine and alternator, consumes only 11,753 B.Th.U. per kWh, and therefore reaches an efficiency of over 58 per cent. of the ideal. The turbine alone, indeed, turns as much as 86·2 per cent. of the heat available into actual work at the coupling and beyond this it would seem almost impossible to go on any commercial machine.

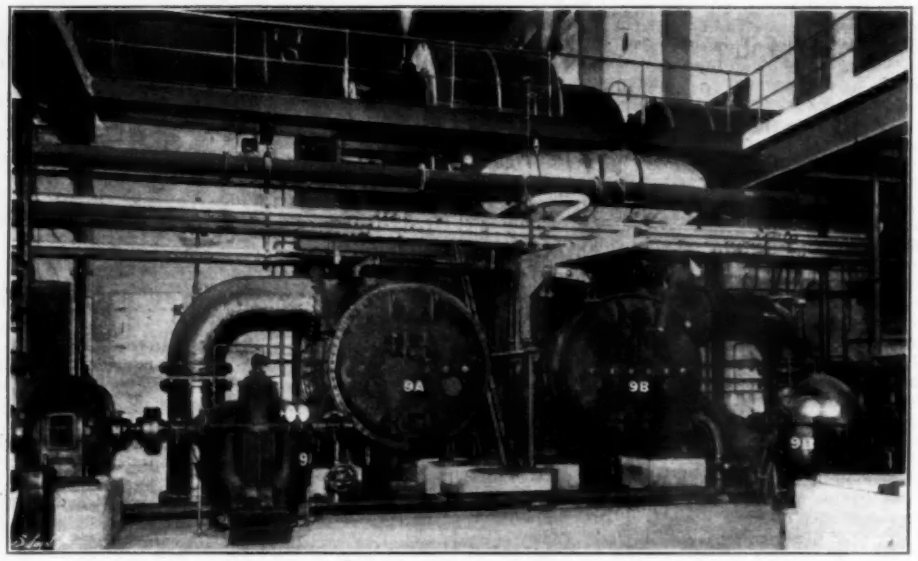


FIG. 2—CONDENSING PLANT FOR 20,000-kW TURBO-ALTERNATOR

So high an efficiency has, of course, only been reached by great skill in design and minute attention to all possible sources of loss both in the turbine and alternator. The two-cylinder arrangement permits of ample blading to be accommodated, so that the steam velocity can be kept low and the best ratio of blade speed to steam speed adopted throughout. There are thirty-eight rows of moving blades in series, of which thirty-one are contained in the high-pressure cylinder. The remaining seven rows are in duplicate, the steam flowing through them in parallel towards the two ends of the low-pressure cylinder. The whole of the high-pressure rotor is machined from a solid steel forging, the low-pressure rotor being built up with discs, on account of its large diameter. The discs are butted together at the hubs and rims so that their vibration is impossible. In accordance with Messrs. Parsons' standard practice, a central hole is bored axially from end to end of each rotor to permit examination of the interior. The bladed portions on both cylinders are of conical form, giving the steam an easy passage and minimising eddying. The blade heights are also favourable to efficiency, being sufficient even in the first row of the high-pressure cylinder to keep the tip leakage down to small proportions, while by the double-flow arrangement in the low-pressure cylinder ample passage way is provided for the low-pressure steam without undue increase in blade height. The blading throughout the whole turbine is of stainless steel with a high surface finish and great accuracy of form. End tightening is adopted for all blading in the high-pressure cylinder, thus further minimising tip leakage while permitting ample radial clearance.

The alternator, also constructed by C. A. Parsons and Co., Ltd., has its stator core built up of silicon steel, affording high permeability and low hysteresis losses. Special attention was given to the insulation between the core plates. Eddy current losses have been kept down in every possible way. They are rendered negligible in the stator conductors by making the latter of stranded cable and are reduced in the end windings by the system of multiple joints adopted. Special precautions have also been taken to reduce losses from eddy currents at the ends of the stator core, particularly in the non-active material, such as core end plates, supporting fingers and winding studs. In the rotor the end caps are bonded to the body, providing an efficient damping circuit and keeping down the eddy currents in the rotor surface. The alternator is ventilated on the closed circuit system, an air cooler and separate motor-driven fan being provided.

Referring again to the general design of the plant, the feature of regenerative feed heating has already been mentioned. For this purpose, steam is bled off at two different points, first in the low-pressure turbine at a pressure of 4·5 lb. absolute, and secondly at the high-pressure turbine exhaust at a pressure of 11·5 lb. absolute, 7200 lb. of steam per hour being taken from the turbine at each point. The steam used by the two-stage air ejector amounts to 1600 lb. per hour. It is condensed in a condenser and feed heater in which the main condensate is used as cooling water, thereby raising the temperature of the latter to 96 deg. Fah. The condensed steam is led by traps back into the main condenser. The drains from the high-pressure and low-pressure heaters are led to a drain heater which raises the main condensate by a further 3 deg. Fah. The low-pressure heater brings

it up to 140 deg. Fah. by steam at 4·5 lb. absolute bled off from the low-pressure turbine, and the high-pressure heater still further raises it to 180 deg. Fah. by steam at 11·5 lb. absolute pressure.

The two surface condensers with their auxiliaries, which are to be seen in Fig. 2, were manufactured in Australia, as called for in the contract. The auxiliaries comprise two motor-driven circulating water pumps, each capable of furnishing half the water required by the plant at full load. A single extraction pump, also motor driven, removes the condensate from the condensers. Including the motor-driven ventilating fan for the alternator, the measured electrical power consumed by the auxiliaries was 251 kW, or about 1¼ per cent. of the maximum continuous load the plant is capable of carrying. In addition to this there is the steam taken by the air ejector, amounting to 1600 lb. per hour.

The results to which we have referred were obtained by tests made by engineers of the New South Wales Railways on site and independently of the contractors, on July 6th, 1928, and were confirmed by further tests carried out on September 24th following. They may therefore be taken as showing, without doubt, what the plant is really capable of doing, and they should be as interesting to power station engineers as they are creditable to the makers of the plant.

The Mid-East England Electricity Scheme.

A NEW electricity scheme covering Mid-East England was recently transmitted by the Electricity Commissioners to the Central Board, and an outline of the scheme was made public for the first time on Saturday, January 19th. The area involved is about 7545 square miles, covering the East and West and part of the North Ridings of Yorkshire, the counties of Lincoln and Rutland, and part of the counties of Nottingham and Derby. At the last census the area showed a population of approximately 4,666,500. Densely populated centres, dealing with coal mining, iron and steel manufacture, textiles and engineering, come within the scope of the scheme, which also affects wide tracts of agricultural territory and a number of important canal, dock and harbour undertakings. In the area there are now seventy-three authorised undertakers, owning, collectively, forty public generating stations, which, during 1927–1928, supplied energy representing about 183 units per head of population. During the year 1934–1935 it is expected that the average consumption per head will have increased to 321 units.

Eighteen existing stations will be selected and operated for the Board, and, although it is not anticipated that any new stations will be required, the scheme provides for three other stations to be worked under temporary arrangements for a few years. In the area there are important sources of waste heat which the Board may be able to use when the transmission system has been erected. The selected stations are Barnsley (Barnsley Corporation), the Barugh, Ferrybridge and Thornhill stations (belonging to the Yorkshire Electric Power Company); the Blackburn Meadows and Neepsend stations (Sheffield Corporation); the Chesterfield station (Chesterfield Corporation); the Foss Islands station (York Corporation); the Halifax station (Halifax Corporation); the Harrogate station (Harrogate Corporation); the Huddersfield station (Huddersfield Corporation); the Hull station (Kingston-upon-Hull Corporation); the Keighley station (Keighley Corporation); the Kirkstall station (Leeds Corporation); the Lincoln station (Lincoln Corporation); the Prince of Wales station (Rotherham Corporation); the Valley-road station (Bradford Corporation); and the Wakefield station, of the Wakefield Corporation. In due course, additions will be made to the plant in some of these stations, the dates by which the extensions will be made being subject to the dates fixed by the Board for the operation of the several selected stations and to the rate of growth of the demand in the area of the scheme. To the Ferrybridge station 50,000 kilowatts will be added for operation by the winter of 1935–1936, and a further addition of 50,000 kilowatts for use during the winter of 1938–1939. New plant of the same capacity is to be added to the Kirkstall station for operation in the winter of 1937–1938, and further plant of 50,000-kilowatt capacity will be ready for the winter of 1939–1940. In the Prince of Wales station 32,000 kilowatts of new plant will be ready for the winter of 1937–1938, and 50,000 kilowatts for the winter of 1940–1941. An addition of 50,000 kilowatts of plant will be ready for work in the Thornhill station during the winter of 1938–1939. The plant in the Blackburn Meadows station will be increased by 25,000 kilowatts by the winter of 1935–1936, and by a further 25 kilowatts by the winter 1936–1937. Broadly speaking, five of the selected stations — viz., Ferrybridge, Kirkstall, Thornhill, Blackburn Meadows, and the Prince of Wales stations—will supply the base load, whilst the remainder will be used for meeting the peak load. It is expected that, in due course, it will be possible to reduce the number of peak load stations. The three stations that are to be operated under temporary arrangements between the Central Board and the owners are at Doncaster, Grimsby, and Leeds.

The stations will be interconnected by a series of high-pressure main transmission lines, in the form of a series of ring mains, so that there will be alternative routes to points of supply, and consequently greater security against breakdown. The lines will be operated at a pressure of 132,000 volts between phases and the carrying capacity of each primary line covered by the estimates will not be less than 50,000 kilowatts. Ring mains, not necessarily completed in the present scheme, but permitting of amplification under subsequent schemes for adjoining areas, have been regarded as an essential feature in the design of the system, and have been included so as to afford alternative routes to points of supply. In designing the size of conductors for the primary overhead lines, regard has been had, among other matters, to the amount of power to be interchanged between selected stations, the amount of standby plant provided at each station, and the necessity for running the most economical stations—base load stations—fully loaded at all times so far as the aggregated load curve for the area will permit and for limiting the amount of load allocated to the less economical stations. The primary transforming stations will be placed so as to be adjacent to the selected generating stations.

The cost of the primary transmission system and transforming stations, after allowing for capitalisation of interest during the first five years, is estimated to amount to £2,907,156. The estimates also include rentals for certain lines which may be hereafter transferred by agreement from the existing owners to the Central Board. There are already many existing secondary transmission lines, which have been or are being constructed by the Yorkshire Electric Power Company, by the Derbyshire and Nottinghamshire Electric Power Company, and by certain municipal corporations.

For the purpose of affording supplies to undertakers who will not be directly supplied through any such networks, secondary transmission lines, operating at 33,000 volts or other suitable pressures, will be established by the Central Board where necessary.

As far as the stations of authorised undertakers are concerned, there is practically no generating plant of non-standard frequency in the area of the Mid-East England scheme. Current is, however, distributed at a non-standard frequency in a number of instances, as, for example, by certain authorised undertakers who derive their supplies in bulk from outside sources, such as colliery undertakings. But as the alteration of these non-standard distribution systems is not essential to the carrying out of the proposed transmission system of the Board, neither the scheme nor the financial estimates make any provision in that behalf.

It is estimated that, by the end of the financial year 1935–1936, the capital expended under the scheme for the Central Board on transmission and by the owners of selected stations on the construction and extensions will be as follows :—

	£
By the Central Board—	
Transmission lines and transforming stations, including capitalised interest	2,907,156
By owners of selected stations—	
On extensions to stations (125,000 kW) ..	1,709,594
	£4,616,750

On the basis of individual development by the various undertakers in the absence of the scheme, it is estimated that the undertakers in the Mid-East England area would have to make provision by 1935–1936 for the installation in existing stations and at Kirkstall of further generating plant amounting to 439,000 kilowatts, inclusive of the above-mentioned 125,000 kilowatts, to meet the load in that year, and to allow for further immediate growth, representing an estimated capital expenditure of £5,406,584. By that year a proportion of the existing spare plant in the several generating stations will have been released for revenue earning purposes, such released plant, amounting in all to about 80,000 kilowatts, and representing an actual expenditure of about £1,360,000. Allowing for the non-release of spare plant in the absence of the scheme, it appears that the system of interconnection for the Mid-East England area, providing improved facilities for subsequent development, can be effected by a capital expenditure up to 1935–1936 of £2,907,156, as compared with an investment of £5,056,990 under the existing system—*i.e.*, the preceding items of £5,406,584, less £1,709,594, plus £1,360,000.

Additional advantages will also accrue by reason of reductions in the cost of generation and savings in capital expenditure, which would otherwise have been necessarily incurred on secondary transmission lines by the individual undertakers. If carried beyond the period under review—1935–1936—the comparison would, it is said, show progressive savings in capital expenditure under the scheme, as compared with individual development, but no actual valuation of these advantages during the subsequent stages of the development has been made.

IT is reported that £20,000,000 worth of agricultural machinery is to be imported into Russia from America with the object of developing ten million acres of grain-growing plain land.

4000 H.P. Locomotives on the Loetschberg Tunnel Railway.

ONE of the most difficult problems of railway operation lies in the handling of heavy trains over steep gradients and through long tunnels. The operation of long mountain tunnels by steam traction, even with special ventilating fan arrangements at each end, involves a limitation of the traffic to be handled, owing to the difficulty with exhaust gases. Those who went through the Mont Cenis in a heavy train before the war know what this means, and an accident in Switzerland some time ago, showed the danger to train crews.

In Europe, the Alps, which with their offshoots stretch from Lyons to Vienna and from Bohemia to Nice, offer an obstacle to international railway traffic, and have, therefore, given scope to engineers in the way of electric traction development, the presence of water power naturally encouraging progress in this direction.

In comparatively recent years the principal Alpine tunnels have been electrified, the Mont Cenis, the Simplon, the St. Gothard, and the Loetschberg. The last of these, with its long approach lines, was the only one designed from the first for electric traction.

Some people have the idea that all the railways in Switzerland, except funicular and other mainly tourist railways, have been taken over by the State. That is not correct, as there are several important lines still in private hands, and of them, perhaps, the most important is the Loetschberg Railway, which handles a large amount of international traffic. This line was built as a feeder to the Simplon to handle mineral and general goods traffic from Belgium, Luxemburg, the Sarre, Eastern France, and the Rhine Valley to Turin and Milan, and to obtain a share of the international passenger traffic from Paris and London to Italy over the French Eastern Railway, *viâ* Delle and Belfort. The Bernese Alps Railway Company also owns several feeder links—the tunnel line between Moutiers and Lequan, a railway from Bern to Neuchatel, a line from Bern to Thun, and also a line from Thun to Interlaken.

The Loetschberg Railway starts at Spietz on the Lake of Thun at an altitude of 631 m.—2070ft.—and for 13·54 kiloms.—8¼ miles—rises to Fruitigen, 782 m.—2566ft.—with long gradients of 1 in 66. There is from this point a continuous rise of 1 in 37 to the northern entrance to the tunnel, a distance of 18 kiloms.—11¼ miles. The tunnel is 9 miles 140 yards long, with a hump in the middle for drainage, and with a gradient of 1 in 71 on the north side and 1 in 263 on the south.

In addition to the through traffic to Brigue, there is on the northern side of the tunnel a considerable passenger traffic over the Loetschberg Railway in the summer tourist season, and in the winter sports season, to resorts in the Kandar Valley, Fruitigen, for Adelboden, and Kandersteg.

On the southern side the tunnel mouth is placed about 2 miles from the wide Rhone Valley. For the first 5½ miles there is a continuous down gradient of 1 in 37, and for the remaining 19 kiloms.—12 miles—there is a gradient of about 1 in 43. On the northern side there are many S curves, including a double loop. On the south side, apart from the first 2 miles, the line lies on a shelf on the northern side of the Rhone Valley, with comparatively easy curves.

The line on each side of the tunnel is single, in the tunnel it is double; the minimum curves are 328 yards radius, and 55 per cent. of the line is on curves. The locomotives used at first were of the ten-coupled type, driven by two single-phase geared motors, each 1250 H.P. on a one-hour rating, connected through transformers to an overhead conductor furnishing current at 15,000 volts with 16⅔ periods.

The greatly increased cost of locomotive labour made it desirable to avoid as far as possible the use of double heading, and to increase the weight of each train to an extent comparable with the length of the sidings available and with the safe stress that could be put on the couplings of stock coming as it does from so many railway administrations.

About the beginning of 1925, owing to the increase in traffic, the railway administration decided to put in hand two locomotives which would handle 560 tons at 31 miles an hour on a gradient of 1 in 37, and a maximum speed of 46 miles an hour, which, in view of the number of curves to be negotiated, necessitated the use of leading and trailing wheels with the Bissel radial truck. Owing to certain difficulties with the crank drive locomotives, it was decided to adopt individual drive to each axle, especially as it had been found that with motors connected electrically in parallel the adhesion could be better utilised than with crank drive.

In view of favourable experiences with the 2000 H.P. 80-ton express locomotives on the St. Gothard section of the Swiss Federal Railways, fitted with the Sécheron design of individual axle quill drive, it was decided to adopt that construction for the locomotives in question, but arranged with six driving axles instead of with three. The locomotives in question were designed by the Société Anonyme des Ateliers de Sécheron of Geneva, the mechanical parts being made by Ernesto Breda of Milan. Each driving axle is driven through spiral springs by a quill shaft with a gear wheel at each end. The quill, in turn, is driven by twin motors. The motors, gears and quill's shafts are supported rigidly on the main frame, the play for the rise and fall of the axles taking place in the annular gap inside the quill.

The geared quill shaft drive was developed in America, six spoke wheels being usually used with a connecting spring from quill to wheel rim between each spoke. It is difficult with something like 20 tons on an axle to reduce the diameter of each driver below about 5ft. 7in., with an unsprung weight below 54 cwt. The Sécheron Company got out an arrangement by which the driving springs are attached to the rim in pairs and to the arms of the spider, also in pairs. By this means the minimum diameter of the drivers can be reduced to about 4ft. 8in., and the fixed wheel base can be correspondingly reduced, a matter of great importance with sharp curves. The unsprung weight is also reduced by nearly 9 cwt. per axle, and a greater up and down play is available. In order to diminish the load produced by centrifugal force, an initial stress is given

THE LOETSCHBERG TUNNEL RAILWAY—4000 B.H.P ELECTRIC LOCOMOTIVE

LA SOCIETE ANONYME DES ATELIERS DE SECHERON, GENEVA, AND ERNESTO BREDA, MILAN, ENGINEERS

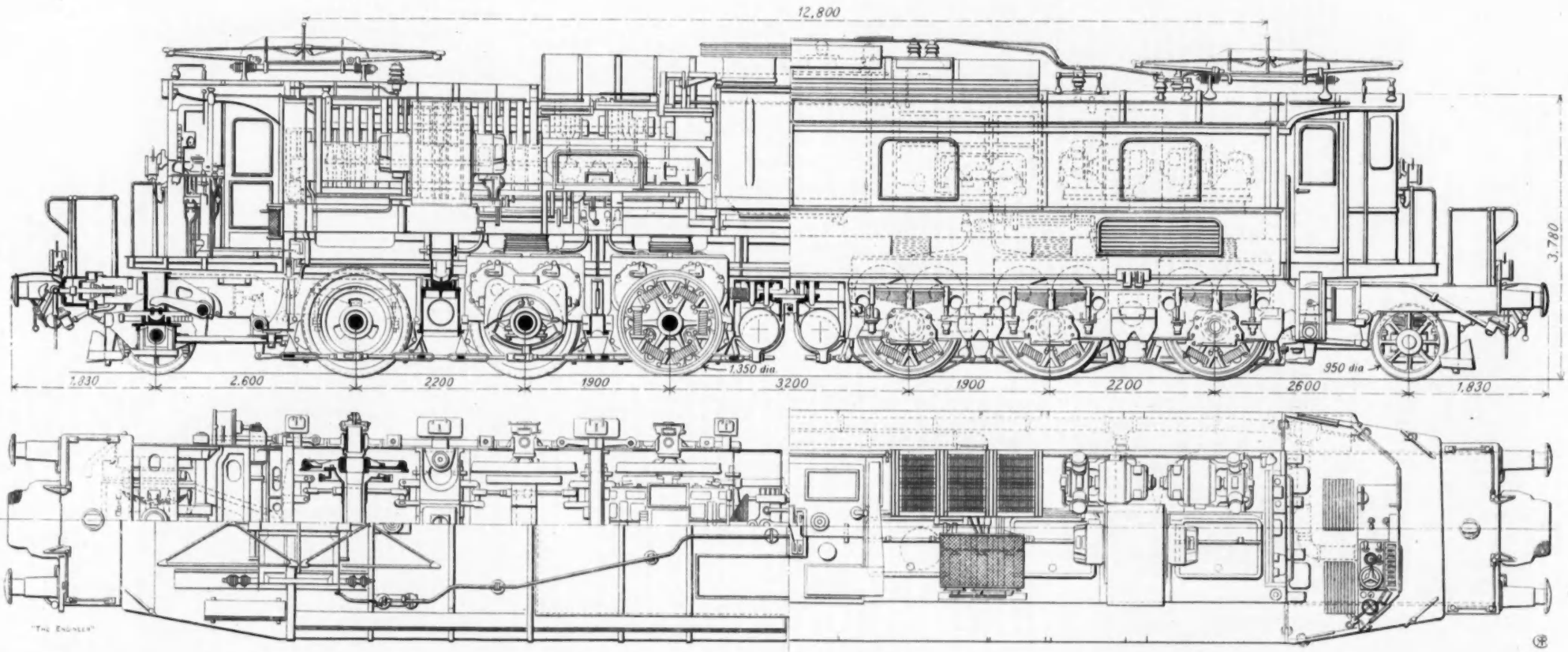


FIG. 1

to the springs. These features connected with the wheel drive are covered by patents.

Fig. 1 shows the general arrangement of the new class of locomotive. Its capacity on a one-hour basis is 4500 H.P., with 3700 H.P. continuous loading.

Leading Particulars.

Length over buffers	20·262 m. (66ft. 5¾in.)
Total wheel base	16·800 m. (55ft. 1in.)
Fixed wheel base each truck	4·100 m. (13ft. 5in.)
Normal speed	50 km./hr. (31 m.p.h.)
Maximum speed	75 km. hr. (46·6 m.p.h.)
Number of motors	Twelve
Capacity of each motor	375 H.P.
Draw-bar pull on one-hour rating	24,300 kilos. (53,557 lb.)
Draw-bar pull on starting	34,000 kilos. (75,000 lb.)
Total weight	141,600 kilos. (139 tons)
Weight on drivers	114,600 kilos. (113 tons)
Weight on each driving axle	18·8 tons

It might be noted that as the locomotives were designed to haul as heavy a train as could be safely taken over the gradients with current draw bars, there would be no object in having a multiple unit system to operate several locomotives together. In view of the cost of power, which has to be purchased, and the rise to be negotiated of 2046ft. from north to south, and 1990ft. from south to north, it

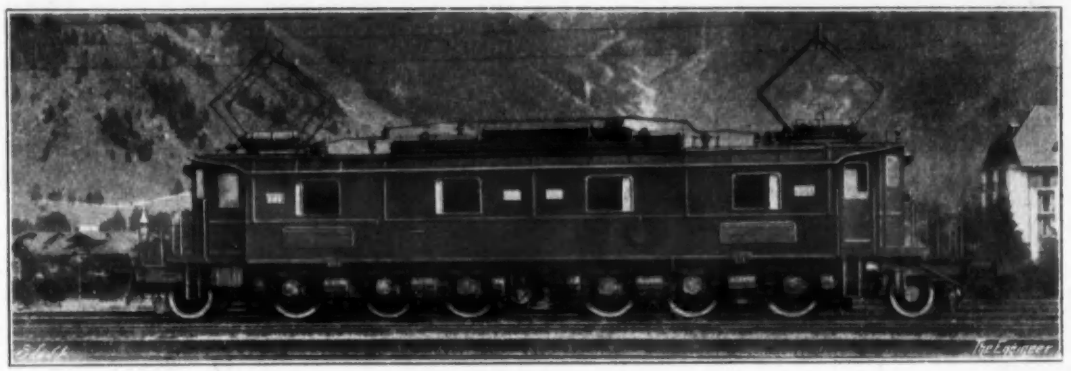


FIG. 2

was important to cut down the weight to a minimum for a given draw bar capacity consistent with a maximum weight of 20 tons per axle.

As a comparison, for haulage on the Natal Mountain section of the South African Railways, three locomotives coupled together are used, each 43ft. 8in. long, 1200 H.P., weighing 66½ tons, but with 18 tons maximum axle load. The Sécheron locomotive has therefore greater power in little more than half the length, with a lower gross tonnage, although single-phase and not direct current is used. It should be remembered, however, that in South Africa the gauge is 3ft. 6in. and the curves much sharper.

The underframe is formed of two trucks connected together by central links and cross bars to facilitate action on curves. Equalisers are fitted to the axles in pairs, the pony wheels being balanced with the adjacent motor axle. The motors rest on joists in such a way that they can be dropped into an inspection pit. The cab rests on two pivots, one of which is fixed, the other having a longitudinal motion. The cab, which is stiffened up, can be lifted off, exposing the motors, and the transformer is attached to the cab.

Hand brake gear is fitted to the driving wheels. It is operated separately on each truck from the driver's cabin. Westinghouse air brakes are employed, but the brake shoes

are on the drivers only. The driving gear on each motor axle is double, the gear wheels being skew cut.

Current is collected by two pantograph bows of special design. To obtain rigidity with minimum weight, only two springs are fitted to each. The gear is protected by a cover. Either of the collectors can be isolated by section links. The main oil switch is placed in the roof of the cab; it is electro-pneumatically operated with auxiliary hand gear.

The main transformer is of the auto-transformer type, with twelve tappings, the motors being arranged in pairs, each pair in series. The tension is reduced from 15,000 volts on the contact wire from zero up to 880 volts in steps. In order to avoid difficulties with pumps and joints under hot oil pressure, the transformer is cooled by means of two groups of steel U tubes, fastened to the cover, dipping into the oil in the upper part of the tank and connected at each end to air trunks. This system has also been used

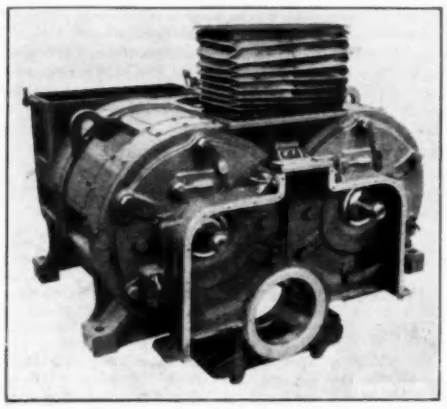


FIG. 3 TWIN MAIN MOTORS

by the Sécheron Company on express locomotives in operation on the Swiss Federal Railways.

The control of the six twin motors is on a new system. The heavy tractive effort available on a locomotive with so much power makes it desirable to move from step to step with the utmost smoothness, to avoid jerks on couplings—a matter of special importance where heavy international passenger trains are concerned. Twenty-four controller positions from starting to top speed were therefore specified.

The arrangement of such a number of positions with solenoid or electro-pneumatic contactors of the usual types would, with interlocking arrangements, involve a very large number of connections and operating contacts, and many hundreds of yards of circuits. Monsieur Meyfarth, the managing director of the Sécheron Company, therefore devised a system by which the valves of a pneumatic contactor system, instead of being operated by solenoids, are operated by hand, with the aid of a light cam shaft, the cams lifting and closing the air valves as required. This system makes for energetic pressure on the contacts, great rapidity of opening and closing of each contact, small angular displacement and low load on the cam shaft and controls. These features have an influence on maintenance.

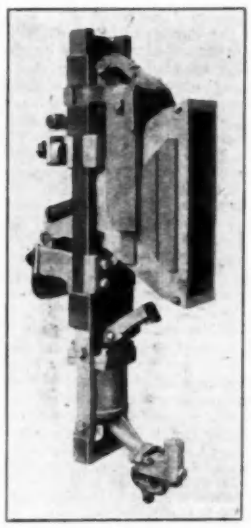


FIG. 4 CONTACTOR

A battery of contactors can be seen in Fig. 5. Each has its air cylinder and valve. The interlocking of each contactor is extremely simple. The further rotation of the cam shaft of the contactor, when it is being opened and has not reached its full open position, is prevented by a finger which comes up against an arm fixed to the contactor. When fully opened the finger and arm miss one another. It is therefore practically impossible for a driver to stop in an intermediate position. The gearing between controller wheel and cam shaft makes a quarter turn equivalent to a contactor step.

In order to deal with emergencies on passenger trains and to facilitate shunting, it is desirable to have an arrangement for instantaneously cutting off the power to the motors. For this purpose a very simple arrangement has been designed. The cam shaft is kept in its position axially by a compressed air piston, held against a spring. By pressing a button on the controller casing, air is released by an electro-pneumatic valve, the cam shaft moves sideways, the heads of the operating valves slip off the cams and the contactors open. To start again, the controller has to be brought back to zero, which action closes the electro-pneumatic valve again and the controller can be notched up once more.

In case the driver tries to force the controller handle against an interlocking finger, a friction disc, which slips, comes into action, and at the same time the main switch is tripped. To minimise the friction on the operating gear, the controller out of use is cut off mechanically from the cam shaft by means of a pneumatic arrangement.

The contactors themselves are of a simple and solidly constructed type. They are opened and closed with a rolling action and four contactors act simultaneously on the normal running points, so that each only carries a quarter of the normal current. The reversers are arranged in two groups of three, each group operated by a pneumatic servo-motor. There are four positions—forwards, stop, brake, and backwards.

With some electrically-operated systems of cam shaft control it is impossible to notch down the steps directly without coming down to zero and notching up again to the desired point, which with a very heavy train involves an increased number of shocks on the electric supply system and jerks on the drawbar; with this system of mechanically-operated valves running steps can be picked up in either direction.

By means of a simple arrangement, any twin motor can be cut out of circuit by putting the individual reverser over to "stop," and locking it mechanically. The twin motors are arranged in series, there being therefore six twin groups in parallel. The windings are of the compensated series type with shunted auxiliary poles. The motors were designed for an output of 700 H.P. per twin group at 31 miles per hour on a one-hour basis. On test, according to the American standard, the output exceeded 750 H.P. These motors operate with a power factor approximating to unity.

The total weight of the locomotive can be braked electrically on resistances. There are thirteen brake positions controlled by the normal contactors after operation of the reverse gear mentioned above. The motors are excited from the line and work into cast grid resistances placed on one of the locomotive trucks in a ventilated trunk. The same truck contains the regulating resistances for the auxiliary poles. To operate the electric brakes the controller is brought to zero, and the contactors therefore opened. The reverser is then turned to the brake position, and the controller advanced again until the excitation gives the desired braking effect. Safety arrangements are

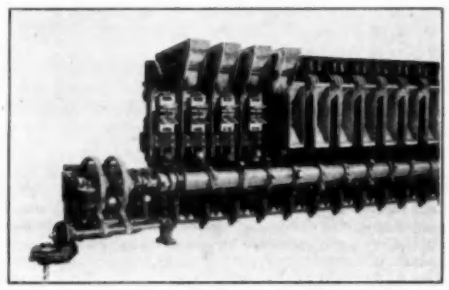


FIG. 5 BANK OF CONTACTORS

provided to prevent the motors being reversed before the locomotive has stopped.

The auxiliaries are operated at 220 volts with single-phase current. There are two ventilating fan groups, one on each truck, each fan being driven by two motors, which can be operated in series or parallel to obtain speed variation. Each fan delivers to an air trunk out of which concertina flexible joints, made of leather, deliver air to the main motors, and to the air ducts leading to the main transformer air cooling coils. One of the groups also cools the resistances. There are two air compressor groups of the piston type, each of a capacity of 1½ cubic metres of air per minute. They are operated with direct-current motors at 36 volts, supplied by a motor generator in parallel with a battery of accumulators. The train can be heated directly by 1000 or 1200 volts current, by means of special tappings. It might be noted that the operation of international trains over electrically operated sections has given rise to considerable difficulties in the matter of train heating.

In each operating cabin, besides a line voltmeter, there is an ammeter indicating the primary current and an

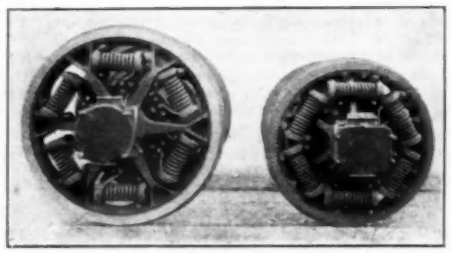


FIG. 6 DRIVING WHEELS AND SPRINGS

ammeter for each of the six motor groups, but the modern traction motor is such a reliable piece of apparatus that it seems doubtful if this last arrangement is "worth the candle." The main high-tension switch has a maximum trip, while each motor group has a maximum relay coil, and so has the heating coil. A no-load trip is used to prevent the current to the main transformer being switched on without passing first through a resistance. The different relay circuits for tripping the main circuit breaker are connected through drop indicators so the driver can see which has operated.

TESTS.

A series of tests regarding the general performance of these locomotives has been made. According to the original specifications, they had to haul a train, weighing 550 tons, at 50 kiloms.—say, 31 miles—per hour up a gradient of 1 in 37, and to start it and bring up to that speed on the same gradient. After the locomotives were delivered, it was quickly found that they could handle trains of 600 tons over the line without difficulty. Later, the Swiss Federal Railways lent their dynamometer car for the purpose of making tests. This car is fitted with recording gear, by which a series of mechanical characteristics can be recorded on the same roll of paper, and a set of electrical recorders is arranged with the recording paper rolls operated at the same speed in synchronism. The following data were recorded by the synchroniser instruments:—The power factor at the locomotive terminals; total power absorbed from the line by the locomotive, in kilowatts; total primary current in ampères; primary tension in volts; power taken by a double motor unit in kilowatts; speed

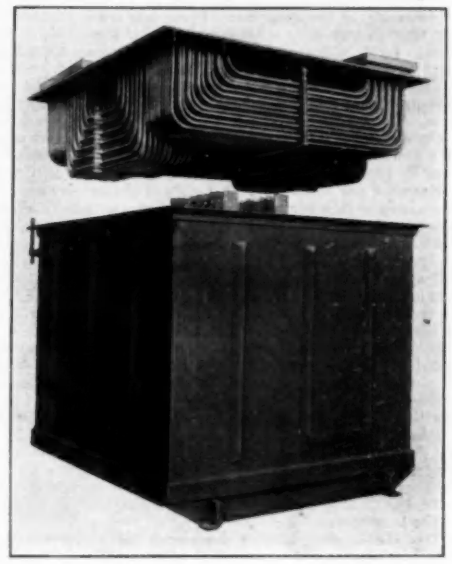


FIG. 7—MAIN TRANSFORMER

in kilometres per hour; forces of inertia—gradients and accelerations at the draw hook—metre, kilogrammes, tons; total work at the draw bar in kilogramme-metres; and time intervals of 6 seconds and 1 minute. The roll was marked with the stations, &c.

A series of tests took place with a train weighing 596 metric tons, a gross weight, including locomotive, of 737 tons. The total length of the train was 325 m. Three runs were made, end to end, and back, followed by a single run from Brigue to Spietz. Under normal operating conditions, each haul to the summit is followed by a run down the other side or back to the starting point; that is to say, each period of heating up is followed by a period of about an hour of cooling under forced draught—the fans being kept going. In order to get the maximum value out of such powerful locomotives as the traffic is very seasonal, heavy north-south at one time of the year and south-north at another, as far as possible these locomotives in practice haul heavy trains to the summit and return with a light train, leaving the duty of taking the first train on down the opposite slope to a locomotive of less power, which can haul up the following lighter train. A series of tests were made of starting the train on gradients of 1 in 37 on a 300 m. curve at Blausee on the north side, and at Hoten

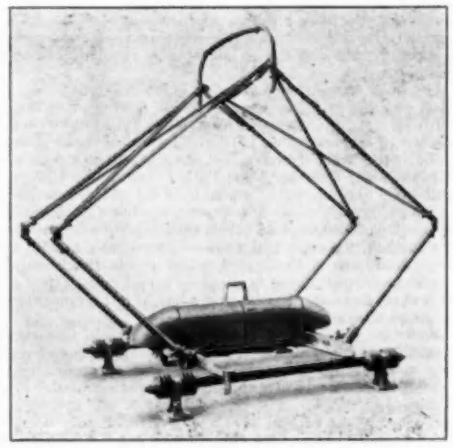


FIG. 8—SECHERON PNEUMATIC PANTOGRAPH

on the south side on a gradient of 1 in 44·2. At Blausee the dynamometer car registered points of efforts of 30,600 kilos. (67,442 lb.) at the draw bar, corresponding to 38,000 kilos. (83,750 lb.) at the driving wheel rims, with weight on the drivers of 114 metric tons, or a coefficient of adhesion of one-third. This remarkable result can be attributed to the independence of the driving axles and to the very flexible transmission between motor shafts and wheel rims. Apart from these momentary points, a steady pull of 30,000 kilos. was obtained on starting on this gradient, corresponding to a coefficient of 3·8. The train reached 50 kiloms.—31 miles—per hour in 512 seconds, corresponding to an average acceleration of 0·027 m. (0·089ft.) per second per second. Taking into account the apparent increase in weight of the train at starting, due to the action of rotating masses, 6 per cent. for the train and 23 per cent. for the locomotive, and the coefficient at starting 1·6 kilos. per ton for the train and 5 kilos. per ton for the locomotive, a figure of 23,800 kilos. is obtained, which corresponds

closely to the curve given, the average coefficient of adhesion being 23·800/114,000, or, say, $\frac{1}{4\cdot8}$.

At the moment of starting when the mechanical power given out is zero, the only power absorbed from the line is that required to make up for the motor electrical losses and the auxiliaries, and the wattless currents in the transformer and motor fields.

It is obvious that the higher these losses, the greater the drop in the line and the lower the power factor. At the moment of starting the auxiliaries take about 7 ampères at 16,000 volts, cos $\varphi = 0\cdot85$. To cover the motor losses the line has to furnish 22 ampères and the transformer 4 ampères, an effort of 32,000 kilos. at the wheel rims and 26,400 kilos. at the draw bar. These last are in phase with the tension and vary with the square of the effort at the rims. With a draw bar pull of 19,500 kilos., 1529 kVA were registered, and at 26,400 kilos., 1987 kVA.

The average magnetising current taken from several measurements was 0·057 kVA per kilogramme pull at the rims. These figures are good for single-phase locomotives.

On a second starting trial made on the southern slope on a gradient of 1 in 44·2, the train reached 34·7 miles per hour in 175 seconds, or an average acceleration of 0·29ft. per second per second. The design of the motors permits of an intense flux with a minimum of magnetising current, and therefore a minimum effect on the drop in voltage of the line. The railway buys its power from a local power company, which owns two stations in the Kandar Valley, the upper station supplying 37 miles of the line. The current is generated at 15,000 to 17,000 volts, and is fed to the line without the intervention of any transformers, so that low wattless current is of great importance.

It might be noted that the design of the locomotive was based on the necessity for starting up the train on the maximum gradient. Tests have shown that it is this, and not heating, which limits the load that can be hauled over the line. The oil temperature in the main transformer reached only 46 deg. Cent., and of the low-tension windings 40 deg. Cent.—both figures very low compared with American traction standards. The temperature of the field coils after an upward journey did not exceed 40 deg. to 50 deg. Cent.—a good result, considering the light weight of the locomotive.

The charts showed that the power factor varied from 0·95 per cent. at 31 miles per hour to 0·97 per cent. at 41 miles. On starting, the factor rose very rapidly and reached 0·90 at 18 miles per hour, a result due to the low wattless current and the action of the compensating coils. After allowing for the resistance per ton, the effect of the curves and the gradient, an efficiency of 67 per cent. is obtained at the draw bar and of 86 per cent. at the wheel rims. The mechanical efficiency of the motors and gearing was about 96 per cent.

The electric brakes on the locomotives are designed to reduce the speed of the locomotive, itself weighing about 140 English tons, from 46 to 6 miles per hour on the down gradient. As a rule, on the down gradients the electric brakes are not worked up to their full capacity, the air fans being kept going to cool the motors right down ready for the next upward journey.

On Swiss railways, as on a number of those of other countries, the transport trade unions insist on two men being employed on an electric locomotive, although one man is allowed to drive a long multiple unit passenger train crammed to the doors. A second man, therefore, has to be carried in the driving cabin, and he has, in the ordinary way, nothing to do but look out for signals, which the driver can see for himself. On a line like the Loetschberg with no complicated junctions, the signals are naturally of the simplest character. On Swiss railways, which, owing to the nature of their through traffic, have to handle a large proportion of foreign stock, locomotives have to be used to a preponderating extent, and the extra cost of the unnecessary assistant driver reduces to a material extent the return on the capital cost of electrification, and acts as a deterrent to its extension. It has, however, been arranged quite recently that goods trains of certain categories can be operated on certain sections by one man.

The bulk of the traffic handled is international coaching stock and trucks belonging to French, German and Italian railways. As the Bernese Alps Railway owns a certain number of wagons fitted with air brakes, air-braked stock is put at the front of each train, so as to reduce the number of brakesmen necessary per train. Owing to the steep gradients, a brakesman is required for every five or six wagons. It might be noted that on the Continent the proportion of air-braked stock is going up; experiences in South Africa and India show how much traffic over steep gradients is facilitated when goods trains can be handled with automatic brakes. With all stock fitted with air brakes, the cost of operating a line like the Loetschberg would be materially reduced.

A run on the footplate with a 505-ton train from north to south was taken by the writer. The starting was remarkably smooth up a gradient at Spietz, commencing at 1 in 66, immediately after leaving the station yard. From Frutigen to the summit, where there is an almost continuous gradient of 1 in 37, the speed repeatedly went up to 31 miles per hour, the voltage keeping between 16,000 and 17,000, and the power absorbed running at times to 3840 kW. Considering the length of the locomotive, the 300-m. S curves were negotiated very smoothly; on steep gradients the motor ventilating fans are thrown into parallel to give the extra draught. Although these locomotives are probably the most powerful built up to date in Europe, yet owing to the use of mechanically-operated contactor gear and twin motors the apparatus in the cab is very get-at-able. A feature of the line is the number of approach tunnels designed for double track, but left single track, with a material amount of rock left in the space which will ultimately be occupied by the second pair of rails.

TESTS made on zinc meta-arsenite as a wood preservative by the Western Union Telegraph Company have shown that the material not only does not increase the conductivity of the wood, but does not reduce its strength as a structural material as do zinc chloride and certain other chemicals, and, in addition, does not affect its capacity to take and hold paint, nor does it have a corrosive effect upon metal with which the wood comes in contact.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

LOCOMOTIVE HORSE-POWER.

SIR,—With reference to your correspondent, Mr. C. M. Keiller's inquiry in your issue of 11th inst., as to the computation of the cylinder and boiler horse-power in modern locomotives, perhaps the following may be of interest to him.

According to Mr. F. J. Cole, of the American Locomotive Company, the maximum cylinder horse-power of a superheated locomotive is reached at a piston speed of 1000ft. per minute. At this piston speed he gives the M.E.P. as (·445 × P) lb., where P = ·85 boiler pressure. From this it can be deduced that maximum cylinder H.P. is given by:—H.P. = ·0229 × P × A, where A = area of one piston in square inches, and P is actual boiler pressure; or, eliminating π, the formula becomes:

$$\text{I.H.P} = \cdot01799 \times d^2 \times \text{P}.$$

This gives a figure which may be depended upon, given ordinary conditions and with average figures for the boiler, and correct steam distribution, and which may, under favourable conditions, be increased somewhat. The above gives the average maximum obtainable, and can be used for ordinary design.

In very recent locomotives equipped with feed-water heaters, "E" type superheaters, long valve travel and high pressure, this formula gives results which may be 50 per cent. to 60 per cent. higher in actual practice, as, for instance, in the case of the new New York Central locomotives, described recently in your columns. In this case the I.H.P. by Cole's method would be 2537, but a maximum of no less than 4295 I.H.P. was obtained. Cole's formula, however, is suitable for ordinary British and continental practice.

With regard to boiler H.P., this figure is normally dependent on several variables, but an approximation may be obtained by the following method, which appears to be that used by Mr. Gresley in giving the data of his new 4–6–0 three-cylinder locomotives.

One H.P. may be obtained from 20·8 lb. of steam at 200 lb. pressure and superheated 200 deg. Fah., both of which figures may be regarded as average. If, then, the amount of steam generated by the boiler can be obtained, then this figure divided by 20·8 will give the horse-power of the boiler.

For example, in the above class the following are the figures.

Heating surface of flues = 460 square feet; evaporation per square foot = 11·52 lb.
Heating surface of tubes 1048 square feet; evaporation per square foot = 10·35 lb.
Heating surface of fire-box 168 square feet; evaporation per square foot = 55 lb.

Evaporation per hour =	460 × 11·52 =	5538 lb.
	1048 × 10·35 =	10,859 lb.
	168 × 55 =	9240 lb.
Total		= 25,637 lb. per hour.

Then B.H.P. = $\frac{25{,}637}{20\cdot8}$ = 1232 (Mr. Gresley gives 1230 for B.H.P. and 1653 for cylinder H.P., which agrees with the result of Cole's formula.

If Mr. Keiller will apply to Messrs. Davis and Lloyd, 26, Victoria-street, S.W. 1, he can obtain the American Locomotive Company's handbook, which gives the above formulæ and tables for evaporation of locomotive boilers.

I trust that this will enable Mr. Keiller to obtain all the data he requires regarding horse-power of locomotives.

H. S. F. SCULLEY.

Addiscombe, January 19th.

THE MARKET FOR ENGINEERS.

SIR,—It appears that as we grow older our tendency is to point to the succeeding generation with a remark that it is not composed of men of a calibre equal to our own. This tendency appears to be responsible in some degree for your article "The Market for Engineers," and while one cannot but sympathise with much you have said, one must consider it open to criticism.

The investigation which you carried out showed that in a small number of cases was a college-trained man specified. From this you argue that the college-trained man is a superfluity and proceed in effect to blame the universities for the alleged backward condition of British engineering to-day. One might assume from your article that experience was all an advertiser asked for, but you would find that in many cases applicants were asked to name a salary, and this introduces another factor which in many cases eliminates the more experienced among the applicants. Again, age is often asked, and your article would lead one to suppose that, *ceteris paribus*, the older man receives the appointment.

What underlies the persistent demand for experience is not the desire for a practical engineer, but the desire for an engineer who has worked in the advertiser's particular line. This is the outcome of the specialisation which has made so many engineering works into factories and has converted the engineer craftsman into a semi-skilled machine attendant. Your contention that practical training should take place in youth is one which will at once find favour with those who, like myself, left school to serve an apprenticeship in a millwright's shop, where the workmen were engineers in the fullest sense. Were the present-day apprenticeship of equal value few would avoid it.

It would be a matter of interest to ascertain what proportion of successful pioneers in engineering ensured that their sons would receive the same stern training as their fathers had. Too many have set a bad example by letting their successors run to seed through the consciousness of an assured future. In these days, when "Jack is as good as his master," it follows that what is good for his master's son is good for Jack's son. The result is a general slacking off all round and it becomes easier to hire a design than to develop one.

Several times in your columns has the writer seen it implied that college graduates expect to step at once into lucrative posts. It is possible that some have an exaggerated idea of their monetary value, but the number must be small and is composed of those who have failed to grasp the object of an academic training which is to help the student to grasp first principles. An original worker is not made either by practical training or by college education, and if such men are lacking it is either through lack of encouragement or through the failure of the older generation of engineers to pass the torch to their successors. Think of the great engineers of the past and consider how many of them would, in their early twenties, have been employed, because of their experience, by an advertiser in the line in which they afterwards became famous. The truth is that, phœnix-like, the British engineering industry can only be rejuvenated by passing through the fire of tribulation.

JUVENIS.

January 21st.

American Engineering News.

A New Refrigerant.

FOR a cooling medium in railway refrigerator cars interesting experiments are being made with solid carbon dioxide, in the form of compressed blocks produced by rapid evaporation of liquid carbon dioxide. This material, known as "dry ice," has a very high latent heat, 276 B.Th.U.'s per pound in passing from the solid to the gaseous state. Thus there is twice the cooling effect of the same weight of water ice. It evaporates at a very low temperature, and the dryness of the gas evolved in melting makes it efficient as an insulating medium. With water ice, the water resulting from its melting is in general objectionable. It must be drained or otherwise disposed of, and it is not easy to prevent the dampening of insulating paper or fibre, which reduces the insulating properties. Besides this, a relatively small amount of "dry-ice" does the work of several tons of water ice, thus reducing the dead load of the car. In the experimental cars, the carbon dioxide does not enter the body of the car or come in contact with the refrigerated contents. On the other hand, for certain classes of perishable freight—particularly green vegetables—moisture is essential, so that 5 to 10 tons of ordinary ice are placed in the body of the car for this purpose. This problem is being considered, however, and it is expected that some system of moisture control can be developed with the use of the carbon dioxide.

Blades of Steam Turbines.

Experiments have been carried on at the University of Illinois to determine the strength of turbine blades of different shapes in resisting continual reversal of bending stresses, as it is known that these blades are subjected to many cycles of bending stress superimposed on a steady stress, due to centrifugal force. The specimens were cut from bars of metal having a cross-section of the same shape and size as the turbine blades, since the actual blades were too small for specimens to be taken from them. They were tested as rotating beams, so that, during a revolution, each specimen was subjected to a transverse bending moment which changed direction through a complete circle. Fatigue cracks started usually at the thicker tip, owing to the location of maximum unit stress under flexure. In most cases the fracture occurred near one of the jaws indicating some localisation of stress near that point. The fatigue strength is proportional to hardness, which was determined by the Rockwell ball test, as the specimens were too thin for the Brinell test. In the Rockwell method the impression is made by a $\frac{1}{16}$in. steel ball pressed against the specimen with a force of 100 kilos. In every case more than 90 per cent. of the estimated endurance limit of the material was developed in the blading specimens, and it is considered as a result that steam turbine blades carefully socketed may be expected to develop nearly the full fatigue strength of the material from which they are made. In this respect the tests agree with the general experience with blades in actual service.

Electrification on the Pennsylvania Railroad.

Official announcement has been made of a programme for electrification of the main line of the Pennsylvania Railroad between New York and Philadelphia, 92 miles. There is already electric operation from the New York station under the Hudson River to the Manhattan Transfer, 3 miles. The first stretch will be from Philadelphia to Trenton, 34 miles, to be completed early in 1930. The suburban lines at Philadelphia will be included. There is electric traction now from Philadelphia south to Wilmington, 27 miles, and it is to be installed between Philadelphia and Columbia, 80 miles, on the main line to Pittsburgh, where heavy gradients are encountered. Eventually it will be extended to Pittsburgh. The programme now authorised covers in all 325 miles of line and 1300 miles of track, to be completed in six or seven years at a cost of about £20,000,000. For main service 163 passenger engines and 200 goods engines will be required, with 218 multiple-unit trains for suburban service. About 318 main line passenger trains will be operated. Goods trains will consist of 125 cars and run at 25 to 30 miles an hour, reducing the present number of trains materially. Single-phase alternating current will be purchased from large power companies. At present the Pennsylvania Railroad has 333 miles of line electrified—including 140 miles on Long Island—with 960 miles of track—including 418 miles on Long Island, opposite New York City.

Railway and Road Matters.

SLEEPING accommodation for third-class passengers has now been provided between Euston and Manchester, Euston and Liverpool, and *vice versâ*.

A CENSUS of the railway-owned and privately-owned wagons, similar to that completed in 1918, is being prepared, and the Ministry of Transport hopes that it will shortly be possible to tabulate the results.

THE Khandala tunnel, which eliminates the reversing station of the Great Indian Peninsula Railway at Bhoreghat, was opened on December 16th last. It is 3103ft. long, cost Rs. 60 lakhs, and will effect an annual saving of Rs. 13 lakhs.

WITHIN the past twelve months the New Zealand Government has purchased from British manufacturers machinery and general equipment, chiefly for the New Zealand Railway Department, of a value of approximately £650,000. Four railway workshops are being established, one in each of the capital cities of the Dominion, and the task of equipping them is still proceeding.

REPORTING on a fatal accident to a platelayer when working in the space between the up and down Euston–Watford electric lines, Mr. Moore, the assistant inspecting officer, says that he found that it was not uncommon for men to remain in the "six-foot" during the passage of trains. That, possibly, was due to the frequency of the service, and he recommends that the L.M.S. Railway Company take early action to prevent these unnecessary risks being taken.

IN his evidence before the Royal Commission on Transport on January 16th, Mr. C. T. Cramp, the industrial general secretary of the National Union of Railwaymen, compared the number of persons killed on the railway with those killed on the road. The former, he said, totalled in 1927 360 and the latter 5329. Mr. Cramp was, however, wrong in his railway figures. There were 360 passengers and servants, but, in addition, 75 "other persons" were killed, besides 356 trespassers and suicides, making a grand total of 791. Despite the fact that this doubles the railway figures tendered to the Royal Commission, the contrast remains remarkable.

WE have just received the report of the South African Railways and Harbours for the year ended March 31st last, which reveals a gratifying period of prosperity. The earnings, when compared with 1926–27, show an increase of 5·02 per cent., with an increase of expenditure of 3·92 per cent. The passenger traffic was the highest on record; the number of passenger journeys was 1·96 per cent. more; the receipts from passenger traffic, 2·35 per cent. greater; whilst the tonnage of goods and coal traffic was 2·47 per cent. higher, and the goods earnings 9·51 per cent. more. The ratio of expenditure to receipts was 79·83, as compared with 80·68 in 1926–27.

WHAT is probably an unparalleled event in railway history—certainly it is so for the last fifty years—is that within the last two months three railway servants have been tried on charges of either manslaughter or, its Scottish equivalent, culpable homicide. To the credit and satisfaction of the whole railway service, let it at once be said that each man was acquitted. They were respectively the driver in the Charfield disaster, the signalman at Queen-street, Glasgow, and the signalman at Wamphray, who irregularly cleared his block instrument for the goods train concerned in the Dinwoodie collision of October 25th and accepted the express from Euston to Inverness and Aberdeen. The last-named man was tried before Lord Kinross in the Dumfries Sheriff Court on Thursday, January 17th, and acknowledged that in a state of confusion, possibly arising from want of rest during the day owing to domestic anxieties, he sent the out-of-section signal for the goods train. He had, however, no recollection of having done so. The jury, after an absence of eleven minutes, unanimously returned a verdict of "Not guilty."

IT was recorded in this column on October 26th that the Ministry of Transport inquiry into the fatal collision of October 12th at Queen-street Station, Glasgow, was held in private. The facts were therefore not publicly known. Railway officers and trade union officials knew that the signalman was at fault, but were hardly prepared for his arrest on November 21st on a charge of culpable homicide. What the man had done was to break the rule that when a train departed through the tunnel on its way to Cowlairs without an assisting engine in the rear, the section was not to be again occupied until the train had passed out of the tunnel. Contrary to that regulation, the signalman allowed an empty carriage train to enter the tunnel. Meanwhile, the driver of the passenger train, owing to a defective sander, was having trouble in ascending the incline, and in his efforts failed to notice, in the dark, that he had reversed his engine, and it was running backwards. It thus struck the empty carriage train very violently, and three passengers were killed. At his trial in the Glasgow Sheriff Court on January 9th and 10th, the jury unanimously acquitted the man.

ACCORDING to a paper read on January 8th at the Newcastle and Sunderland Railway Lecture and Debating Society, the London and North-Eastern Railway has forty-four Sentinel-Cammell steam rail coaches—twenty-four chain-driven and twenty gear-driven—and ten Clayton coaches. It was observed that it is rather too soon to say definitely what will be the average cost per mile, but it may be suggested that a double-crewed steam coach, working 200 miles per day, costs per mile about half that of an ordinary steam train. There have been quite a number of instances where new services, at first given by steam rail coaches, have proved so popular that it has become necessary to introduce ordinary trains. The Sentinel Waggon Works have produced a light shunting engine, one of which works between Hull and Selby, and shunts the wagons in their requisite order in anticipation of the arrival of the pick-up freight train. The paper in question states that as a consequence it has been possible to rearrange the steam engine working so that two only are required instead of three. In that case, as well as at another place, the Sentinel engine is estimated to be making economies in working costs sufficient to pay for itself within two years.

Notes and Memoranda.

THE Royal Institution proposes to celebrate in 1931 the centenary of the fundamental electric discoveries of Faraday, and a special meeting to discuss the proposal will be held at the Institution on February 5th.

ACCORDING to LeRoy W. McCay, of Princeton University, the following procedure for the quantitative separation of arsenic from antimony is effective. A solution of arsenic acid and antimonic acid in moderately dilute hydrofluoric acid is rendered slightly, but distinctly, alkaline by addition of ammonia; then an excess of silver nitrate is added; the arsenic is precipitated completely as silver arsenate, free from antimony. The precipitate is collected on a filter; and the antimony is present in the filtrate.

A SHORT article in the *Journal* of the Royal Society of Arts points out that the modern weldless steel tube is applicable to the requirements of hundreds of industries, many of which have already discovered in it a means of simplifying production, increasing output, reducing costs, and improving quality and finish. Tubular products are used in the construction of thousands of articles, and are in daily requisition for component parts of plant and machinery. The possibilities of the modern weldless steel tube are only beginning to be realised. The essential fact is that we have a process by which steel of all grades from "low carbon" to chrome molybdenum and stainless, may be economically worked—a process that bids fair to revolutionise manufacture in many directions.

MANGANESE is said to be a constituent of most rocks and is readily dissolved in ground water and reprecipitated. In the belt of lakes that lie along the south edge of the area covered by glaciers in the northern United States during the continental glaciation manganese and iron oxides have been found, here and there, in quantities that warranted mining. Most of these deposits have not yet been covered by sediment, but there was recently discovered in southern Idaho a mineable bed of manganese oxides that had been deposited in a lake of the glacial period and later covered by 100ft. of silt. Up to May 1st, 1927, it had yielded 1200 tons of high-grade manganese ore. Proof of its ancient origin was shown by the presence of several teeth of an extinct mammoth under the bed.

IN the *Bulletin* of the Imperial Institute there is a note on the use of mangrove wood for paper making. Three species of wood were tested, and the microscopical characters of the three pulps are described, while an account is given of experiments to manufacture paper from them. In general, for satisfactory pulping the mangrove woods demand severe treatment which would be so expensive as to be prohibitive, and the papers which they furnish are very weak. The manufacture of bleached pulp would therefore be impracticable. It is considered, however, that it might be possible to prepare a coarse, unbleached pulp specially designed for wrapping-paper, but the results so far obtained are not conclusive. In any case, owing to the weakness of the material it could not be converted into papers at all comparable to kraft and Manila papers.

FULL and final determination of the causes responsible for the collapse of the large and almost new bascule bridge over the Hackensack has not yet been reached, but on all accounts it is a most disquieting accident. "The evidence strongly, if not convincingly, points," says *Engineering News-Record*, "to a structural failure. Yet steel bridge construction is one of the most thoroughly developed arts of modern engineering, one in which stress calculation and exact proportioning of material to service are carried much farther than in other branches of the structural art. Moreover, the test of practice places in our hands many checks on theory, and experience in maintaining steel bridges makes it possible to discover and correct defects revealed by the pounding of traffic. In view of these conditions, when a new bridge of modern design collapses without the slightest warning and in the absence of external attack, bridge engineering finds itself under indictment. The situation is of greater gravity because one part of the bridge on which primary suspicion rests is a guide frame which did not carry load stresses and yet was exposed to complex sets of deformation effects and other secondary actions. To clarify the relation of such elements to the strength of the bridge structure is of basic importance. Fortunately an able board of engineers has been named to investigate the accident. It is to be hoped that their study of the case will be thorough and searching in the extreme and go beyond the mere immediate factors of causation and responsibility. It is essential that bridge-building practice be fully cleared of the indictment and that it once more be placed beyond suspicion."

A PRESS which has been devised by Professor J. W. Hinckley for extracting water from peat consists of a series of chambers 4in. wide, provided with pistons. The sides of the chambers are covered with woven wire gauze having heavy warp wires, supported on perforated plates. The pistons slide on the strips of metal which are used to hold the filtering surfaces in position, and at the same time protect them from wear from the piston itself. This method of construction avoids the direct pressure of the press being applied to the filtering surface, the flow of the liquid being also at right angles to the direction of the pressure. The peat in this case behaved nearly as a semi-fluid and at the end of the operation the pressure at the end of the cake furthest from the piston was less than half that at the piston itself. At the beginning of the stroke, however, this pressure was four-fifths. Arrangements were made so that before the stroke started steam could be blown through the filter surfaces, first in one direction and then in the other. Superheated steam is used, to avoid condensation of water in the cake as much as possible. It is admitted for about two minutes to one side of the cake, and then two minutes to the other side of the cake. In twenty minutes, by increasing pressures, the operation is concluded, half the weight of the peat charged appearing as hot water, and hot peat containing approximately 50 per cent. of water is discharged from the press. The amount of energy required for the steaming process is ten times that required for the pressing. In order to evaporate the amount of water eliminated, fifty times the energy required for pressing would be required.

Miscellanea.

A NEW observatory is to be built on the high land at Chikingshan, Nanking.

A NEW pier is to be built on Burrard Inlet, Vancouver, alongside the Ballantyne Pier.

THE Press view of the Birmingham Section of the British Industries Fair is to be held on Friday, February 15th.

A PLANT employing the L. and N. process is to be put up in Tasmania, for distilling the local shale, at a cost of £50,000.

DURING last year over 550,000 horse-power was added to the hydro-electric resources of Canada, bringing the total up to 5,328,000 H.P.

IT is reported that Courtaulds, Ltd., has acquired the interests of the Croatian Bank in the Teslic Wood Distillation Company in Jugo-Slavia.

DURING 1927 the Finnish State works produced about 10,500 tons of sulphuric acid, which was chiefly used in the manufacture of superphosphates.

THE electric trams of Johannesburg are prospering so well that it has been decided to extend the lines to Hospital Hill and the Waterworks plantation.

IT is anticipated that the output of the North Atlantic Gypsum Company from its quarries at Cheticamp, Nova Scotia, will be 350,000 tons during this year.

A NATURAL gas well with a flow of about 40 million cubic feet a day has been "brought in" in the Cypress Hills, Alberta, about 300 miles south-west of Regina.

IT is hoped to finish the Government House, New Delhi, during the autumn of this year. The building covers 5 acres, and will, when finished, have cost 1¼ millions sterling.

IT is proposed to establish a ship-repairing plant near Prescott, Ontario, by the Playfair Company. The same firm is about to build two 254ft. freight steamers at Ogdensburg.

A CAMPAIGN has been worked out for drilling in the vicinity of Blacksmith Rapids, on the Abitibi River, Ontario, with the object of determining the limits of the local lignite beds.

MORE than 3000ft. of wharfage was constructed, and an area of some 400,000 square feet of land was reclaimed from the river by the Montreal Harbour Commissioners during the past year.

DURING eleven months of last year Canada produced 232,957 motor cars, valued at 146,502,561 dollars. There was an increase of 33 per cent. in number and of 27 per cent. in value over the corresponding period of 1927.

IT is proposed to replace the masonry conduits of the New Delhi waterworks between Idgak and Talkatora by steel pipes. The work will cost about Rs. 2,83,000, and is necessitated by contamination of the water supply.

A SUGAR-REFINING plant is to be added to the Brigg beet sugar plant in Lincolnshire. It will work on imported cane sugar during the slack time after the beet sugar campaign is over. The plant will cost between £70,000 and £80,000.

A TRAIN ferry is to be arranged across Northumberland Strait, New Brunswick, between Cape Tormentine and Borden, Prince Edward Island, at a cost of 1,000,000 dollars. The vessel is to have a deck for motor cars, which will be run aboard under their own power.

MOTOR transport has proved such a boon for the Shasi, China, public that the omnibuses are always overcrowded. Owing to insufficient car accommodations, the Shansi authorities have recently bought a number of new omnibuses to relieve the congestion.

SOLDIERS of the 2nd Army are being employed on road-making in the Changsha district of Hunan, China. This is only a preliminary step towards the adoption of a vast scheme for utilisation of soldier labour, including the dredging of the Tungting Lake, and the construction of the Hunan section of the Canton–Hankow Railway.

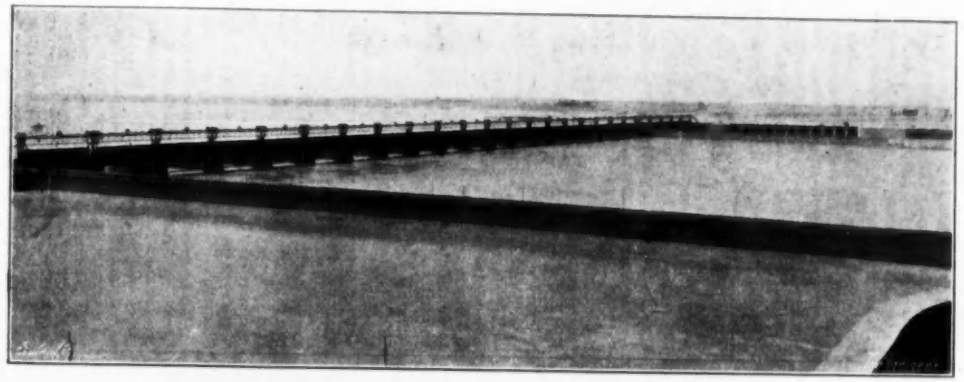
IT is proposed to add a 15,000 horse-power unit to the Jordan River hydro-electric power plant at Victoria, British Columbia. The Jordan River installation is one of the highest head water power plants in Canada. Situated 36 miles west of Victoria, at the mouth of the Jordan River, the plant operates under an average head of 1145ft.

THE ferry bridge at Duluth, Minnesota, is to be replaced by a lifting span. The structure of the existing bridge is to be heightened, and the new bridge then built within it. The original steel work will be left in place to strengthen the new work. The present clearance height of 135ft. is to be maintained. The lifting span will weigh 1300 tons, and will be lifted to the full height in 60 seconds.

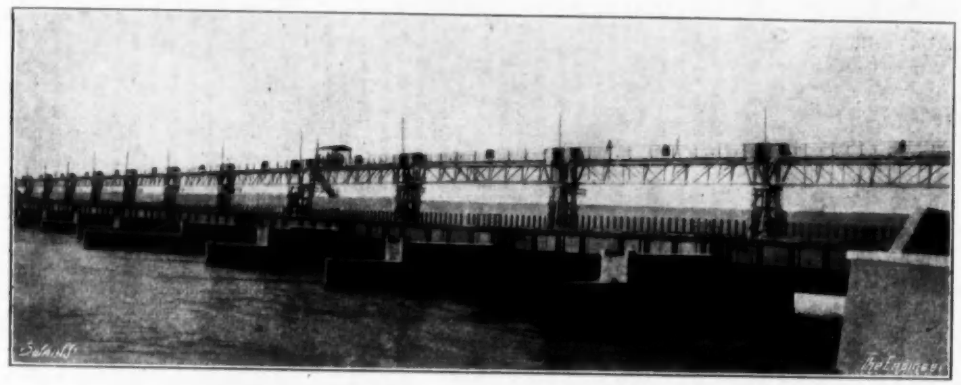
AFTER being two years under the waters of Sydney Harbour, the old wooden man-o'-war "Pelican" is, says *Canada*, to be raised, restored to her original condition, and set up here as a permanent example of the fast-vanishing "wooden walls" of Old England. She is the only memorial of this kind, it is believed, in Canada, if not on the whole Atlantic seaboard. When obsolete as a warship, the "Pelican" became the property of the Hudson's Bay Company, and was used in sub-Arctic exploration and commerce until 1916, when she was requisitioned for active service as an ammunition carrier between England and France.

A DISASTROUS and spectacular fire at 7.30 p.m. on December 22nd swept through the wood scaffolding being used to erect the interior stonework and the ceiling of sound-proof tile in the Riverside Church, New York City, and damaged the partly completed structure to an amount of several hundred thousand dollars. Although the major damage is believed to have been confined to the interior stone facing and that part of the cut stone decorative work that was in place, parts of the structural steel frame were exposed to the action of the flames, and it is not possible, says the *Engineering News-Record*, until further investigation to determine whether or not these were damaged.

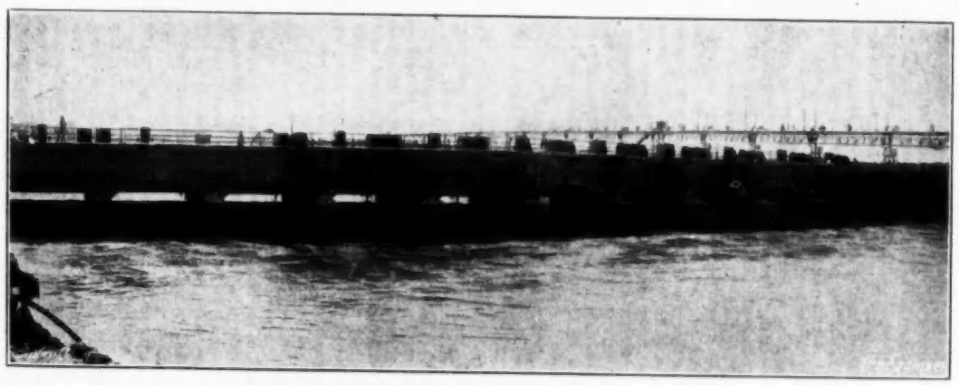
(For description see page 93)



FEROZEPUR WEIR FROM LEFT ABUTMENT OF KAISAR-I-HIND BRIDGE



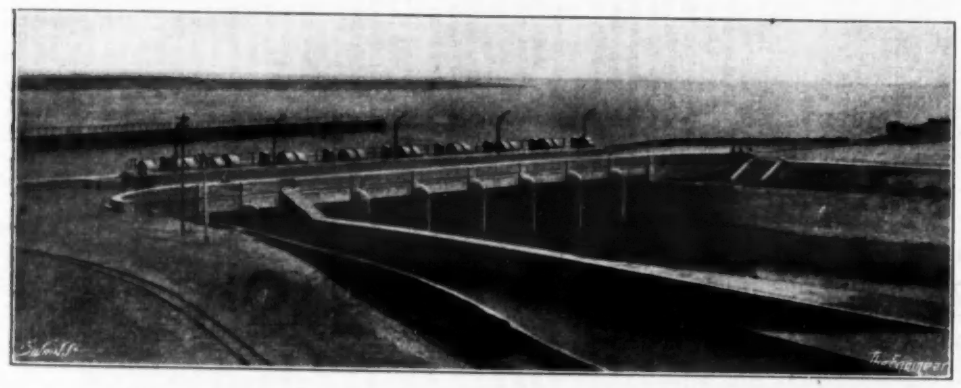
FEROZEPUR WEIR FROM DOWNSTREAM LEFT FLANK WALL



DEPALPUR CANAL HEAD REGULATOR FEROZEPUR

SADIGIA AND FORDWAH CANAL REGULATORS SULAIMANKE

ISLAM WEIR, DOWNSTREAM VIEW FROM LEFT FLANK



BAHAWAL AND QAIMPUR COMBINED HEAD REGULATORS DOWNSTREAM VIEW

The Engineer
Annual Subscription Rates

(including postal charges).

Subscriptions will be accepted by the Publisher direct or through a newsagent at the rates and in the currencies stated below :—

BRITISH ISLES	.. ..	£3	5	0	
CANADA	.. .. ..	£3	3	0	Thick Paper edition.
		£2	18	6	Thin Paper edition.
ABROAD	.. .. ..	£3	7	6	Thick Paper edition.
(except Canada)		£3	3	0	Thin Paper edition.

AFRICA .. .. Central News Agency. All Branches
* £3 7s. 6d. CAPE TOWN : Wm. Dawson and Sons, Ltd.,
† £3 3s. 0d. 29–31, Long-street (Box 489)
JOHANNESBURG : C. Juta and Co.

ARGENTINA .. BUENOS AIRES : Mitchell's Book Store, 576,
* £3 7s. 6d. Cangallo
† £3 3s. 0d.

AUSTRALIA .. Gordon and Gotch (Australasia), Ltd. All
* £3 7s. 6d. Branches
† £3 3s. 0d. MELBOURNE : Robertson and Mullens, Elizabeth-street

BELGIUM .. BRUXELLES : W. H. Smith and Son, 78–80,
* Fr. 590 Rue du Marché-aux-Herbes
† Fr. 550

CANADA .. .. American News Company, Ltd. All Branches
* $15·25 MONTREAL : Gordon and Gotch, Ltd., 334,
† $14·25 Notre Dame-street, W.
TORONTO : Wm. Dawson and Sons, Ltd., 87, Queen-street East
TORONTO : Gordon and Gotch, Ltd., 81, Queen-street West.

CEYLON .. .. COLOMBO : Wijayartna and Co.
* Rs. 44·5
† Rs. 41·5

CHINA .. .. HONG KONG : Kelly and Walsh, Ltd.
* $37 SHANGHAI : Kelly and Walsh, Ltd.
† $34·5

EGYPT .. .. CAIRO : Express Book and Stationery Store,
* £3 7s. 6d. (Pt. 330) 9, Chareh Maghrabi
† £3 3s. 0d. (Pt. 308)

FINLAND .. HELSINGFORS : Akademiska Bokhandeln,
* M. 650 Alexandersgatan, 7
† M. 605

FRANCE .. .. PARIS : Boyveau and Chevillet, Rue de la
* Fr. 418 Banque, 22
† Fr. 390 PARIS : Berger Leverault, 229, Bld. St. Germain
PARIS : Brentano's, 37, Av. de l'Opera
PARIS : Dunod, 92, Rue Bonaparte

GERMANY .. BERLIN : H. Hermanns, Friedrichstrasse 218,
* R. mks. 70·00 S.W. 48
† R. mks. 65·00 WESTERN GERMANY : Fritz Rehfus, Blumenthalstrasse 10, Cologne
LEIPZIG : K. W. Hiersemann, Konigstrasse 29

HOLLAND .. ROTTERDAM : Hector's Boekhandel, Noordblaak 59
* Fl. 41·00
† Fl. 38·00 ROTTERDAM : Techn. Boekhandel, "Plan C," Gelderschestraat 4

INDIA .. .. BOMBAY : Thacker and Co., Ltd.
* Rs. 45 CALCUTTA : Thacker, Spink and Co.
† Rs. 42

ITALY .. .. MILAN : Ulrico Hoepli
* Lire 300 ROME : Maglioni and Strini, 307, Corso
† Lire 280 ROME : Fratelli Treves, Corso Umberto I, 174
ROME : Fratelli Bocca

JAPAN .. .. Maruzen Co., all Branches
* £3 7s. 6d.
† £3 3s. 0d.

JAMAICA .. .. KINGSTON : Educational Supply Co.
* £3 7s. 6d.
† £3 3s. 0d.

NEW ZEALAND AUCKLAND : Whitcombe and Tombs, Ltd.
* £3 7s. 6d. Gordon and Gotch, Ltd. All Branches
† £3 3s. 0d. NAPIER : J. Wilson Craig and Co.

RUSSIA .. .. LENINGRAD : Mezhdunarodnaya Kniga, Prospect Volodarsky, 53 A
* £3 7s. 6d.
† £3 3s. 0d. MOSCOW : "Litiadat," Kousnetsky Most, 5–15

STRAITS SETTLEMENTS—SINGAPORE : Kelly and Walsh,
* $29·25 Ltd.
† $27·25

SWEDEN .. .. STOCKHOLM : A/B Wennergrens Journal-
* Kr. 61·00 expedition, Stockholm 1
† Kr. 57·00 STOCKHOLM : A/B C. E. Fritzes Kungl., Hofbokhandel, Fredsgatan, 2

SWITZERLAND BERNE : Joh. William De Groot, Laupenstr. 5
* Fr. 85·20 ZURICH : Rosa Leibowicz, 4, Ankerstr.
† Fr. 79·50

UNITED STATES OF AMERICA International News Co., 131, Varick-street, New York, N.Y., and all Branches
* $16·40 Entered as second-class matter at the Post Office,
† $15·25 New York, N.Y., December 12th, 1896, under the Act of March 3rd, 1879 (Section 397, P.L. & R.)

* *Thick Paper.* † *Thin Paper.*

These rates are liable to alteration if exchange fluctuations require it.

*** READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

"THE METALLURGIST."

This Supplement, which deals with the Science of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER in each calendar month.

ADVERTISEMENTS.

The charge for Classified Advertisements is 1/- per line up to one inch —minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication).

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. Central 2256, 2257.

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents

THE ENGINEER, January 25th, 1929. PAGE

A SEVEN-DAY JOURNAL .. 89
AUTOMATIC WEIGHING MACHINES. No. I. (Illus.) .. 90
RETARDATION AND PREVENTION OF OXIDATION. No. II. .. 92
THE SUTLEJ VALLEY PROJECT .. 93
INSTITUTION OF MECHANICAL ENGINEERS .. 95
RECORD EFFICIENCY OF A TURBO-ALTERNATOR. (Illus.) .. 96
THE MID-EAST ENGLAND ELECTRICITY SCHEME .. 97
4000 H.P. LOCOMOTIVES ON THE LOETSCHBERG TUNNEL RAILWAY. (Illus.) .. 97
LETTERS TO THE EDITOR—
Locomotive Horse-power .. 100
The Market for Engineers .. 100
AMERICAN ENGINEERING NEWS .. 100
RAILWAY AND ROAD MATTERS .. 101
NOTES AND MEMORANDA .. 101
MISCELLANEA .. 101
LEADING ARTICLES—
Future Naval Construction .. 103
The Registration of Tests .. 104
LITERATURE .. 104
MODERN FEED WATER CIRCUITS. (Illus.) .. 106
L.M.S.R.—HIGH-PRESSURE LOCOMOTIVE .. 108
SIXTY YEARS AGO .. 108
B.E.S.A. SPECIFICATIONS .. 108
A HACKSAW FACTORY. (Illus.) .. 109
GRINDING MACHINE FOR LOCOMOTIVE PARTS. (Illus.) .. 109
FURTHER PROGRESS IN CRYSTAL ANALYSIS .. 110
A CHAPTER IN THE HISTORY OF THE WATER SUPPLY OF LONDON. (Illus.) .. 110
POWER FROM WARM WATER .. 111
NOTES ON THE FITTING AND OPERATION OF MICHELL BEARINGS 111
SOUTH AFRICAN ENGINEERING NOTES .. 111
A NOVEL DISINTEGRATOR. (Illus.) .. 112
PROVINCIAL LETTERS—
The Midlands and Staffordshire—Lancashire .. 113
Sheffield—North of England .. 114
Scotland—Wales and Adjoining Counties .. 115
PERSONAL AND BUSINESS ANNOUNCEMENTS .. 115
CATALOGUES .. 115
LAUNCHES AND TRIAL TRIPS .. 115
CURRENT PRICES FOR METALS AND FUELS .. 116
FRENCH ENGINEERING NOTES .. 117
BRITISH PATENT SPECIFICATIONS. (Illus.) .. 117
FORTHCOMING ENGAGEMENTS .. 118

SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST."

NOTICES TO READERS.

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

The Metallurgist.

THE JANUARY NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

JANUARY 25, 1929.

Future Naval Construction.

AT first glance the question of future warship design may not appear to be one of immediate importance. As our readers are aware, capital ship construction has been suspended by the Washington Treaty, and cannot, in any event, be resumed before 1931, while the same instrument, by imposing limits on tonnage and armament, has virtually standardised cruiser design the world over. There is, nevertheless, a certain urgency in this question, for, unless we are greatly mistaken, the naval constructors of Great Britain, the United States, and Japan are already at work on tentative plans for the ships which may have to be laid down two years hence. So far as the United States is concerned, authoritative evidence on this point can be quoted. In its statement of policy issued on November 13th last the Navy Department announced its intention, *inter alia*, "to prepare and maintain detailed plans for new capital ship construction," and "to replace existing capital ships in the years specified in accordance with Treaty provision." As regards our own policy, the First Lord of the Admiralty, when submitting the current Navy Estimates to Parliament on March 15th last, alluded to "the possibility of having to replace battleships at the expiration of the time of the Washington Convention." That this possibility is regarded by the Admiralty as a probability may be inferred from the remarks made by Vice-Admiral Sir A. Chatfield—then Third Sea Lord—at the launch of the "Rodney" at Birkenhead on December 17th, 1925. "It is not the sailors' view," he said, "that this is probably the last battleship that will be built. Rather do we look upon her as the first of a great new line, and we hope that many other 'Rodneys' and 'Nelsons' will be built in the future." Numerous messages from Tokyo indicate the resolve of the Japanese naval authorities to build new capital ships under the Treaty replacement rules. Again, there are unofficial advices from Paris to the effect that France, in view of the accelerated obsolescence of her heavy ships, and still more in consequence of the advent of Germany's remarkable armoured ships of the "Ersatz Preussen" class, is reconsidering her decision to build no more capital units and will, sooner or later, construct "small battle-cruisers" of 17,500 tons. Clearly, therefore, the pause in heavy construction is not likely to be permanent.

There are two ways of looking at the Washington Treaty so far as it affects capital ship design. The taxpayer may regard it as an unqualified blessing, in that it has checked what threatened to develop into a ruinous competition in tons and guns between our own country, the United States, and Japan. It is undoubtedly the fact that, on the eve of the Washington Conference all three Powers contemplated the building of ships that would have cost from eight to nine millions each. To the enthusiastic naval designer, however, the Treaty is less attractive. Writing in "Brassey's Annual" for 1923, Sir George Thurston described it as "an artificial restriction on the progress of scientific achievement." He went on to point out that if the research work of recent years in gunnery, propelling machinery, and protection were to be utilised to the fullest extent, it would be essential to raise capital ship displacement to something like 57,000 tons, or 22,000 tons above the Treaty limit. In that case, we think, a great many people in this country will deem it fortunate that diplomacy intervened in the nick of time. Long-suffering and patriotic though the British people is, we fear it would have jibbed at the prospect of rebuilding the Fleet on the basis of £9,000,000 ships. Nor are we satisfied that such enormous dimensions are indispensable to tactical and strategical efficiency. Few naval officers of our acquaintance dissent from the view that in pre-war days the cult of bigness was carried too far. The outstanding lesson of Jutland with regard to material was that mere size is no talisman of victory. Given a common standard of marksmanship, the gun of medium calibre—"medium in this sense signifying 11in. to 13·5in.—has proved itself to be at least equal, if not superior, to the heavier but slower-firing gun. Thanks to its superior ballistic qualities the latter would doubtless score at very long ranges, but in the light of experience gained in actions during the war, and in post-war full-calibre "shoots," does anyone seriously contend that future naval engagements will be decided by gunfire at any range above 20,000 yards? Our own impression, founded on data gleaned at first hand, is that naval artillery duels fought at any range exceeding 20,000 yards will be indecisive and merely result in a waste of ammunition. Advanced methods of fire control, aircraft spotting, increased muzzle velocities, and improved projectiles, all these have contributed to make gunfire more accurate—up to a point. Even so, visibility remains the imponderable yet dominant factor, and, in the western hemisphere at least, it will always exist as the principal obstacle to accurate shooting beyond the distance we have mentioned. Now at 20,000 yards the ballistic qualities of the 13·5in., or even the 12in. gun, do not suffer greatly by comparison with those of the 15in. or 16in., and the former weapons have the advantage of superior rapidity of fire. We are often invited to consider the tremendous effect of a well-aimed salvo from the 16in. guns of the "Nelson," each of the projectiles weighing roughly a ton. Without doubt, a direct hit by even one of these levin-bolts would prove very destructive, but would it do more damage than the impact of two 13·5in. or three 12in. shells? War experience suggests a negative answer. If that be so, a strong case could be presented for the smaller gun, which could probably fire twice as rapidly as the 16in. In other words, a vessel training ten 12in. guns on the broadside would be able, within a given period, to deliver a volume of fire but little inferior in weight to that of a vessel with nine 16in. guns, and, other things being equal, the more numerous guns would register more hits. It may be, of course, that the vitals of the "Nelson" are proof against 12in. projectiles fired at long range, though we are not prepared to endorse that assumption off-hand. While our future policy of construction must necessarily be determined in some degree by that of other Powers, we see no cogent reason why, if other Powers elect to go to the limit in displacement and calibre, this country should follow tamely in their wake. There is good evidence that the American replacement ships planned for 1931 will be designed up to the Treaty maximum of 35,000 tons and mount ten 16in. guns. The appearance of such mastodons would doubtless

provide a strong, if superficial, argument for the building of similar ships for the British Navy. We hope, however, that our naval directors will take a broader view, and not allow themselves to be drawn into a tonnage and gun-power competition which bears no actual relation to British requirements. They have already shown praiseworthy enterprise in breaking away from the standard Washington type of 10,000-ton cruiser and producing, in the "York" class, a type of cruising ship which, while being smaller and cheaper, is admirably adapted to the special needs of British strategy. In capital ship construction our policy should be guided, not by what America—whose naval problems differ fundamentally from our own—chooses to do, but by the requirements and contingencies of the future. Is there, for example, no lesson for us in the new orientation of naval design on the Continent? Let us assume, for the purpose of argument, that the German "Ersatz Preussen" type finds favour with other naval Powers and is widely reproduced. Confronted with the task of dealing with such vessels, our present battle fleet would be almost impotent, nor would the addition of a dozen "Nelsons" or "County" cruisers help to solve the problem. If a ship of the "Ersatz Preussen" class were harrying British trade it is difficult to see how, with our present resources, she could be brought to book. Her speed of 26 knots, and her cruising endurance of 10,000 miles at 20 knots, would enable her to elude battleship pursuit, while with her armament of six 11in. guns she could easily overwhelm any cruiser that ventured within range. She would, in fact, be immune from any type of ship other than the battle-cruiser, and of such ships we have but four. The projected French vessels of 17,500 tons, eight 12in. guns, and 33 knots speed, would raise the same problem in an aggravated form.

So many developments in foreign naval design are either foreshadowed or actually in progress that it would surely be a grave error on our part to concentrate on the planning of improved "Nelsons." The real question, it seems to us, is not whether we ought to lay down more "Nelsons" in 1931, but whether we can afford to be bound much longer by a Treaty which inhibits us from building anything between a 35,000-ton, 16in. gun battleship and a 10,000-ton, 8in. gun cruiser. When France and Italy signed the Treaty each expressly reserved the right of employing the capital ship tonnage allotted to her as she might consider advisable—that is, the right of building ships of any displacement from 10,000 tons up to 35,000, and of arming them with any gun from 8in. up to 16in. This reservation gives each of the two Powers a liberty of action which might be invaluable in certain circumstances. We see no reason why Great Britain should not be granted the like freedom, and so enabled to deal with the new problems of defence as they arise. Since the United States is chiefly interested in naval equality on the basis of aggregate tonnage, she could not consistently raise an objection to such a proposal. The point we would stress is that the future naval requirements of the Empire cannot be met by 35,000-ton capital ships and 10,000-ton cruisers alone. The evolution of intermediate types is only a question of time, and we must be free to amend our building policy in accordance with changing conditions of strategy.

The Registration of Tests.

AMONG manufacturers of power plant machinery the question of guarantees of efficiency is becoming more and more a subject of heartburning. It is right and natural that such guarantees should be called for by the purchaser, for the difference of a fraction of a pound of steam per kilowatt hour in the consumption of a large turbo-generator has a very considerable capital value. Hence the firm that can promise the lowest steam consumption has a good chance of obtaining the order, even at a price which may be substantially higher than that of its competitors. This state of affairs has a good and an evil side. On the one hand, it puts a premium on good design, and, on the other, it incites the less scrupulous firms to promise efficiencies higher than they are likely to attain. Desirous of securing the contract and knowing the consumptions their rivals have previously obtained, they cut their guarantees a shade finer, trusting to luck and to the room which always exists to argue about test conditions, to evade any penalty which they may rightly incur. It is very unpleasant to have to say such things, but there is nothing to be gained by ignoring facts which are discussed almost wherever engineers foregather. Impossible guarantees are, moreover, not necessarily put forward from sheer dishonesty. It is more charitable to assume that they are often the outcome of genuine ignorance associated with a reckless belief that "if they can do it, we can." But whether the root of the evil lies in ignorance or dishonesty, it is a matter of great importance to all reputable manufacturers that unfair competition based on outrageous promises should be put an end to.

The obvious remedy is for purchasers to make accurate tests of performance and to impose stringent penalites for any failure to give the efficiency guaranteed. It is easy to say this, and it is, in fact, what is supposed to be done now; but the evil shows no signs of abatement. In many cases real tests are never made at all, the purchaser being content, provided the machine will do its work satisfactorily, to accept the assurance of the maker as to its fuel or steam consumption. Such a laxity is doubly unfair to the best manufacturers, as it prevents them getting the credit of a good performance, while at the same time the chance of a test not being made encourages their less honourable rivals to promise anything to get the order. Since, however, purchasers cannot be compelled to test the plant they buy, there will always be a field for unduly optimistic promises, though fortunately those who suffer the most from them will be, in the main, those who deserve to. A test, to be worth anything at all, has to be carried out thoroughly, and the expense of doing this on site is often so great that purchasers hesitate to incur it. The provision of all the specially calibrated apparatus is bad enough, but when to this is added the trouble of the maintenance of steady specified loads for the machine simultaneously with the specified conditions of steam pressure, temperature, and vacuum, and the finding of the necessary number of reliable observers, the temptation to omit acceptance tests altogether may be too strong to be resisted. Again, even when tests are run on site, the impossibility generally of providing precisely the conditions for which the guarantees were given, opens the door to a multitude of "corrections" and "adjustments" of figures by means of which almost any desired result may be arrived at. The alleged performance of the machine on the maker's test bed may be adduced as another argument, and, finally, when the matter is settled, the purchaser may have a machine which will penalise him in his fuel bills for twenty years or more, while manufacturers who would have obtained their guarantees have suffered from the loss of an order to less competent rivals. It is the latter aspect of the question which we wish to consider particularly. There is something essentially unjust in a state of affairs which permits contracts to be obtained by false pretences. It is all very well to say that an unscrupulous firm will not flourish long; that sooner or later its failure to live up to its guarantees will be so generally known as to discount its efforts to obtain more business. Perhaps so, but at all events it may flourish quite long enough to do enormous harm to its more honest competitors. Every order it gets strengthens its own position and weakens that of its rivals, and such of its failures to redeem its promises as become known are soon forgotten or explained away. However the matter is looked at, the protection of the best manufacturers is bound up with the question of tests. Every test carried out under standardised conditions and certified to by some engineer whose reputation is a sufficient guarantee of the genuineness of the figures, is an assurance to the purchaser of the quality of the class of machinery concerned. The Heat Engine Trials Committee has done good work in indicating the lines along which tests should be conducted and in standardising, as far as possible, the manner in which the results should be presented. The time, to many engineers, seems ripe for a further move. If some body or society, whose name would carry the same weight as that of Lloyd's in inspection work, or of, say, the National Physical Laboratory in the calibration of instruments, would make it its business to register all approved tests, a great step would be taken towards the suppression of unjustifiable claims. No test would be registered unless carried out according to definite rules with instruments and apparatus of approved type. The exact figures obtained, free from any "corrections," would be insisted upon, and both the results and the statement of the conditions of the test would have to bear the signature of an independent engineer acceptable to the society. A further condition of registration would be the inclusion of sufficient data to enable the performance to be analysed, and its merits estimated. The minimum length of test and the minimum number of readings to be recorded in all tests intended for registration would be specified. The recommendations of the Heat Engine Trials Committee might well form a basis of requirements, though certain ways of securing data could be definitely ruled out. Indeed, the stricter and more precise the conditions to be fulfilled before a test would be entered on the official register, the better. Once entered, it would be a sort of hallmark of the plant concerned, to which the manufacturers could always refer as evidence of the merits of their design. Firms securing the official registration of the performances of some of their typical machines would find the fact very useful when confronted by the efficiencies promised by rivals who were unable to produce such evidence of performance. Also, in cases of new designs, the certified record of efficiency would go far to remove the reluctance of some customers to purchase a comparatively untried type. It would be the essence of the scheme that the register of tests should be available to everyone interested, so that it would act as a permanent advertisement of good performances. These, it may be said, are advertised widely enough as it it is, but the difference would be that the evidence of the register would show whether the performances were or were not accepted as trustworthy by a body of engineers competent to judge of the value of the tests.

Something in the nature of a register of authoritative tests of power plant is surely wanted for the protection both of the manufacturers and the public. It would also have a beneficial influence on design. For a designer to know what certain types of machines had unquestionably done, and to know, further, exactly under what conditions they had produced those results, would hardly fail to result in further progress. It is, however, in the protection of reputable manufacturers that the strength of the claim for the official registration of tests would seem principally to lie. Manufacturers, however, from the nature of things, could not well take part themselves in the work of registration, and they would certainly not support any body of whose competence and fairness they were not convinced. Yet there should be no insuperable difficulty in finding a body capable of rendering so important a service to the power plant industry. One or other of the great engine and boiler insurance companies might be induced to add this work to the valuable assistance they already give to manufacturers, or possibly the Fuel Research Board could extend its present registration of the performances of carbonising plants to cover a wider field. It is not absolutely necessary that the registering body should conduct all or even any of the tests itself. Those carried out by consulting engineers of standing would, in principle, be acceptable for registration, provided the standard conditions were complied with. The main thing is to discover some practical means whereby manufacturers capable of getting the best results should be protected from those who promise more than they can perform, and the way would seem to lie in the registration, by some authoritative body, of such tests only as are of indisputable accuracy.

Literature.

British Floods and Droughts. By C. E. P. BROOKS, D.Sc., Hon. Sec., Royal Meteorological Society; and J. GLASSPOOLE, M.Sc., Ph.D., Professional Associate, Institute of Water Engineers. London: Ernest Benn, Ltd. 1928. Price 10s. 6d.

READING this most interesting book brings home to us, not only how much has been done towards forecasting the weather, but also how much more remains to be done. When accurate records of the weather have been kept, not only in the British Isles, but also all over the world, for some—possibly many—centuries, we may hope to be able to forecast the weather, with some certainty, a few months, or perhaps years, in advance; but, at present, that is impossible.

The book is divided into an Introduction and three parts. The Introduction deals with the rainfall of the British Isles. The average normal barometric pressure about the British Isles shows an area of low pressure around Iceland and an area of high pressure about the Azores. The shifting of these areas produces most of our changes. Appreciable rain is almost always caused by raising moist air to a higher and colder level. This process is effected, mainly, in three ways:—(*a*) A cyclone may force a layer of moist air up an incline of cold air or a wedge of cold air under the moist air, thus producing what is called "cyclonic" rain; or (*b*) a steady wind may meet with a range of hills, thus producing what is called "orographic" rain; or (*c*) there may be thunder rain.

Severe summer thunderstorms usually occur in comparatively calm weather, and on fairly flat ground. The layer of air upon the earth becomes highly heated, but is prevented from rising by the cold and still upper layer, which, however, ultimately gives way in a place or places, and the hot moist air then rushes through the hole or holes.

Part I. of the book deals with great rains and floods, and Chapter I. gives the causes of persistent rain in this part of the globe. The chief cause is the movement of the Icelandic depression and the Azores anticyclone. When the depression moves southward we may expect wet. The causes of these movements are very obscure, as they depend on the general circulation of the earth's atmosphere One cause is variation in the temperature of the Gulf Stream, and that, in its turn, depends, mainly, on the amount of ice in the Atlantic, which is brought down by persistent north-west wind along the coast of Labrador. Thus, say the authors, "we find that out of the thirteen wettest seasons between 1879 and 1924, no fewer than nine were immediately preceded by a period of such strong north-west winds." Again, "Ice has a great power of cooling the air above it, and since cold air is heavier than warm air, it follows that barometric pressure tends to be increased by the presence of a large amount of floating ice." The authors add, "This does not by any means exhaust the various factors which go to make up the vagaries of British weather. But whereas we are beginning to have some understanding of the way in which the Gulf Stream, the Labrador current and the Arctic ice 'work,' with regard to other factors we have only the merest glimmerings." It has even been suggested that the Nile floods have an effect on our climate, but that is not likely, though the two phenomena may have a common origin.

Another possible cause is that of volcanic eruptions, which, by throwing vast quantities of spoil into the air, cut off sunshine. Thus it is estimated that Krakatoa in 1883 shot a cubic mile of dirt 40 miles up into the air, giving us glorious sunsets for two years afterwards, though we are thousands of miles away from the volcano. The chapter, however, gives details of other examples which suggest doubts as to whether these eruptions have any effect on our climate. "It seems, therefore, that we must be sceptical as to the part played by volcanic eruptions in the variations of our weather." The influences at work on British weather are, conclude the authors, "many and exceedingly diverse. That is unfortunate, in that it greatly increases the difficulty of forecasting the weather for any period longer than twenty-four hours."

The next five chapters are concerned with rainfalls in recent years and in past centuries, and with floods. The largest amount actually recorded in a rain gauge in one year in this country is 247in., or as much as falls ordinarily in London in a decade. In discussing floods it is pointed out that rains are not by any means their only cause, and the Thames flood of January, 1928, is quoted as an example to the contrary. It may be pointed out that if ever we have, at exactly the same time and all at their extremes, a high spring tide, a north-westerly gale in the North Sea, a south-westerly gale at the mouth of the Channel, an easterly gale at the mouth of the Thames, a low barometer, and much upland water coming down the Thames, we shall have a flood which will throw even that disaster into the shade. Fortunately, however, such a combination is extremely unlikely. Probably, the authors remark, most floods have been caused or assisted by high tides, but serious floods have followed the bursting of embankments and dams. As examples of floods are quoted the formation of the Zuyder Zee between 1086 and 1250, the Sheffield flood of 1864, the Dolgarrog flood in North Wales in 1925, the Mississippi floods of 1926 and 1927, and many others.

Perhaps the most interesting portion of the volume is that devoted to cycles of weather. Chapter XIV. begins by telling us that the search for such cycles is as old as history, but it goes on to say that periodic phenomena "are not only small in comparison with the accidental or irregular variations; they are not even entirely regular or permanent, but have an unfortunate tendency to break down at critical moments and to start again at the wrong time." Apart from the annual periodicity, curves are given of seven others, and they are combined in a single curve, so that it is easy to compare what the rainfall would have been had it been governed by these seven periodicities with what it actually was as shown by a second curve. Commenting on these the authors say: "It will be seen that while there is a certain amount of agreement, especially in the general trend of the two curves, the details are often woefully at fault. The wet period of the 'seventies and early 'eighties is faithfully reproduced by the calculated curve, and the dry period of the 'nineties is shown fairly well, though with some differences of detail. The very dry year 1887 is represented on the calculated curve by a drop to only just below normal, while even worse, the very wet year 1903 is also calculated as slightly drier than normal. On the other hand, the dry year 1921 is well represented by a pronounced dip in the calculated curve, and the wet spell from 1922 to 1927 is also fairly well reproduced." There have been all sorts of suggestions of other periodic terms which should be included, and there is even some very slight evidence in favour of a 1000 year period.

The book concludes by expressing some vague hopes that 1928 is the beginning of an improving period.

All the World's Aircraft, 1928. Edited by C. G. GREY. Compiled by LEONARD BRIDGMAN. London: Sampson Low, Marston and Co., Ltd. Price £2 2s. net.

THE eighteenth edition of "All the World's Aircraft" affords us an opportunity at an appropriate time of taking stock of the world's aircraft-building activity, and how it is divided among the chief countries. The five principal nations producing aircraft and aero-engines are Great Britain, France, Germany, Italy and the United States. Seventy-five per cent. of the world's aeroplane-building firms are concentrated in these five countries, and 90 per cent. of the world's aero-engine builders. A detailed examination of the pages of "All the World's Aircraft" has enabled us to draw up the following interesting little table, showing the number of aeroplane builders and aero-engine manufacturers in the countries named :—

	Number of firms making Aeroplanes.	Aero-engines.
Great Britain	20	10
France	30	12
Germany	15	6
Italy	13	4
United States	80	20
All other countries	51	6

In extracting the figures for this table we have not attempted to discriminate on any basis between the builders and makers listed in "All the World's Aircraft." In particular, we have counted as separate firms the branches or licensees of undertakings established outside the country of origin, and have placed these branches to the credit of the countries in which they carry on their business. The figures are, we think, instructive up to a point. Of chief interest is the fact that this country is before all others in its ratio of engine manufacturers to aeroplane builders. These two branches of the aeronautical industry must be regarded together, for if a country has to depend for its engines to any considerable extent on foreign suppliers its aeroplane industry cannot be regarded as healthy. It might be thought that in this respect the United States is poorly served in the matter of aero-engine makers It is not so, however. Among the eighty builders of aeroplanes in that country are numerous small undertakings, while among the aero-engine makers are several very large concerns, such as the Curtiss, Pratt and Whitney, and Wright companies. As a consequence, with one or two minor exceptions, all United States aeroplanes of to-day are fitted with native engines. A similar state prevails in this country, but in France and Germany—particularly in Germany—engines of British manufacture or engines produced abroad to British designs are in very extensive use.

The large number of aeroplane builders in the United States may come as a surprise to some. As we have already said, many of them are at present working on a small scale, but we ought not to rely on their activities remaining on this basis. In the United States there are clear signs of a "boom" in civil aviation, and of a financial "boom" in the stocks of aircraft manufacturing and operating companies.

Without some knowledge of the annual outputs of the firms listed in "All the World's Aircraft," we cannot properly judge from the table we have given the relative magnitudes of the aeronautical industries in the countries named in it. It is certain, however, that the position of this country is far better than the figures given in the table would imply. We have only to study the pages of "All the World's Aircraft" with a little care to see that not only British engines, but British aeroplanes enjoy great popularity abroad. Even in the United States British machines and engines are now being, or are about to be, made under licence. In countries outside the five specifically named in our table, the products of British aeronautical manufacturers are shown to occupy a very advanced position in popular and official regard.

It is gratifying to note, on the other side of the picture, that the British aeronautical industry shows a healthy disinclination to manufacture foreign designs under licence, and in that respect is in notable contrast with the country's heavy oil engine industry. Messrs. Roe have acquired the manufacturing rights for a Fokker (Dutch) machine. Messrs. Beardmore are similarly interested in the Rohrbach (German) system of metal construction; and Messrs. Vickers in the "Wibault" (French) designs. The Fairey Company is, or was until quite recently, interested in the production of a British version of the American Curtiss D 12 engine. Beyond these instances, we know of no serious invasion of this country by foreign inspiration. That fact is doubly gratifying to those who can recall the early days of the British aeronautical industry. Right up to the beginning of the war we were largely dependent on the ideas of foreign aeroplane designers, and were almost completely dependent on the products of foreign aero-engine builders. In August, 1914, and for many months afterwards, our mainstay in the air was the "B E" class of machine, a Farnborough design, which, as the initials implied, was an experimental modification of principles employed by Bleriot. Two other types also used by us in the earlier stages of the war were the "F E" and "S E" machines, representing respectively "Farman experimental" and "Santos Dumont experimental." It is desirable perhaps to recall these facts, for they are apt to be forgotten. Quite recently we noticed a well-known aeronautical authority chiding another for what he alleged to be a misinterpretation of the initials "F E" and insisting that they stood for "fighting experimental." His error seemed to us symptomatic of a general tendency to forget the debt which British aeronautics in its early days owed to foreign designers. That debt, as the latest edition of "All the World's Aircraft" clearly shows, has now been repaid in full measure.

Modern Steam Boilers: Their Construction, Management and Use. By E. PULL. Second edition, revised and enlarged. London: Ernest Benn, Ltd. 1928. Price 25s.

THE title of this book must not be taken to imply that it is entirely or even mainly concerned with the latest developments in boiler practice. In the eyes of the author every kind of boiler which is not obsolete is modern, so that space which might have been better utilised is devoted to illustrations and descriptions of such well-known types as Lancashire, Scotch, Cochran, vertical and other boilers. Of more interest to power station engineers are the descriptions of the Babcock and Wilcox, Yarrow, Stirling, Vickers, Thompson, Bigelow, Heine, Durr, and Sulzer boilers, though the cursoriness of their treatment has enabled all of these and several others, including variants of design, to be disposed of in a single chapter of 66 pages. The book is not one which could be of much help to the boiler-house engineer. Its most useful function would seem to be to acquaint students with the types of apparatus which are in commercial use for steam raising. The appeal to the student is strengthened by chapters on "Boiler Materials" and on "Boiler Construction," the latter illustrating various kinds of plate joints and methods of staying flat surfaces, and giving a number of formulæ useful in calculating strengths. Mechanical stokers are not referred to at all, but oil firing gets a little attention and pulverised fuel firing is dealt with sketchily in 8 pages, with particular reference to the Atritor pulveriser and the Buell burner.

Such criticism as the book calls for applies principally to a chapter entitled "The Generation of Steam." The author still puts forward Regnault's formula, now over eighty years old, for the total heat of steam, and gives a steam table based on Regnault's ancient work, though he unfortunately misspells the name of the great French physicist in a way which suggests confusion between him and a famous motor car manufacturer of the same nation. The student is certainly told that more accurate tables can be found in Ewing's book on the steam engine, but their computation is attributed to Dr. Mollier. Not a word is said of the existence of any of the tables in daily use by engineers. Similar want of touch with modern practice is the endorsement of the custom of stating boiler evaporation in terms of "from and at," a practice condemned by the Heat Engine Trials Committee. Again, we are told "the power of a boiler should be in terms of horse-power," another endorsement of an obsolete and condemned practice. Furthermore, in spite of the ordinary calculations relating to the combustion of fuel and calorimetry being fully explained, there is not a word calling attention to the discrepancy between the higher and lower calorific values, if we except a few lines added on to a section dealing with the amount of air required for the combustion of hydrogen, from which the existence of two calorific values for ordinary fuels could be inferred by a student sufficiently alert.

BOOKS RECEIVED.

The Motor Ship Reference Book, 1929. London: Temple Press, Ltd., 5–15, Rosebery-avenue, E.C. 1. Price 5s. net.

The Motor Electrical Manual. Fourth edition. London: The Temple Press, 5–15, Rosebery-avenue, E.C. 1. Price 2s. 6d. net.

"*Mechanical World*" *Year Book*, 1929. London: Emmott and Co., Ltd., 20, Bedford-street, W.C. 2. Price 1s. 6d. net.

The Ice and Cold Storage Trades Directory, 1929. London: Iliffe and Sons, Ltd., Dorset House, Tudor-street, E.C. 4. Price 11s. net.

Workshop Practice. Two volumes. Edited by E. A. Atkins, M.I. Mech. E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 6s. per volume.

Electrical Transmission and Distribution. Vols. I. and II. Edited by R. O. Kapp, B.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 6s. per volume.

Art de l'Ingénieur et Métallurgie; Extrait du Vol. VI. des Tables Annuelles de Constantes (1923–1924). Paris (VI.): Gauthier-Villars et Cie., 55, Quai des Grands-Augustins. Price 100f.

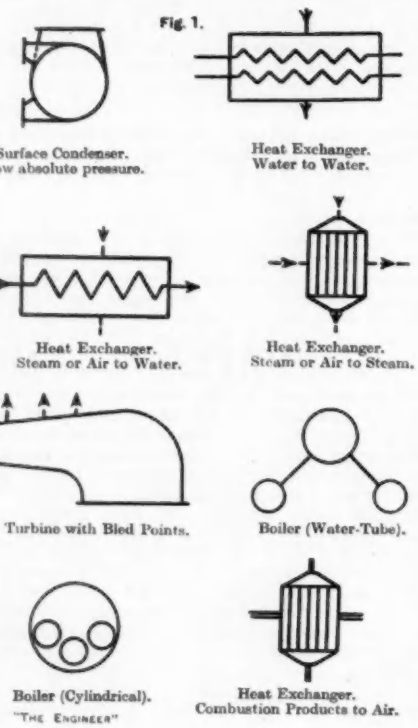
Report by H.M. Inspectors on Day Classes for Engineering Apprentices, being Educational Pamphlet No. 66 (Board of Education, Industry Series No. III.). London: H.M. Stationery Office. 1928. Price 3d. net.

Modern Feed-water Circuits.*

By J. G. WEIR, C.M.G., C.B.E., Member.

THE fundamental cycle traversed by the working fluid in all steam power installations is from boiler to power generator, from power generator to condenser, and from condenser back to boiler. Superimposed on this simple circuit there are generally a number of subsidiary heat exchanges. Further complexity is introduced when leakages to the working fluid have to be considered, together with the necessary provision for make-up. The importance is now generally realised of considering the feed circuit in detail in order to establish a proper heat balance of the installation and to choose the best among the various alternative circuits available. Many factors enter into the consideration of the best feed circuit, such as the steam pressure adopted, the type of boiler used, the nature of the load factor, and the quality of the water available.

Fig. 1.


Surface Condenser. Low absolute pressure.
Heat Exchanger. Water to Water.
Heat Exchanger. Steam or Air to Water.
Heat Exchanger. Steam or Air to Steam.
Turbine with Bled Points.
Boiler (Water-Tube).
Boiler (Cylindrical).
Heat Exchanger. Combustion Products to Air.
"THE ENGINEER"

Moreover, where very high steam pressures are used, there is an increasing tendency to introduce in various form what may properly be termed a "sub-circuit." The material in the "sub-circuit" may be used merely as a vehicle for the transference of heat as in the Schmidt process, or it may itself form a work cycle as in the system described later in Fig. 18. Moreover, the sub-circuit may be of another material, such as mercury, having physical characteristics better suited to the conditions.

The characteristics of the various circuits can be most conveniently studied by means of conventional diagrams starting with the simpler and more fundamental cases and proceeding later to consider the modifications and complications which have to be introduced to meet special conditions.

For the purpose of simplifying the diagrams it will be convenient to utilise the conventionalised notation shown in Fig. 1. Using this notation, the fundamental feed circuit is represented by Fig. 2. The arrangement shown is impracticable because there is no method of controlling the amount and distribution of the working fluid in the circuit, *i.e.*, as different rates of evaporation require different quantities of water in the boilers, the excess water at the higher rates of evaporation would cause flooding in the condenser.

The simplest method of overcoming this difficulty is shown in Fig. 3. In this arrangement a surge tank has been inserted in the circuit between the condensate pump and the feed pump. The boiler level may now be controlled by a float as indicated, and variations in quantity of the water in circuit will be compensated automatically by the surge tank.

This is a feed circuit frequently used in power station practice. It has the defect that the surge tank is exposed to the absorption of air which may find its way into the active circuit and so cause corrosion in the boiler or other parts of the system. Moreover, in some cases, particularly in marine installations, the static head necessary for an effective surge tank is not available. An alternative and more complete solution is to retain the original closed system but to provide automatic overflow and make-up connections to an external surge feed tank, as in Fig. 4.

This arrangement gives a complete flexibility in operation between the feed requirements of the boiler and the condensate delivered by the condensate pump, and works well in practice. The automatic make-up and overflow valves are generally operated through relays by floats situated in or connected to the bottom of the main condenser, and operate in such a way that there is maintained a predetermined water level on the suction side of the condensate pump.

The distribution of water in the circuit is controlled by the water level in the boilers. Should there be too much water in the circuit the condensate pump withdraws it from the condenser, and as the feed pump is controlled on its delivery the water level rises in the condensate suction pipe and causes the float-operated relay to operate and open the overflow valve; this allows the surplus water to escape out of the circuit into the feed tank. Should the converse condition arise and the feed pump demand more water than is forthcoming from the condenser, the water level in the condensate suction piping will fall and the float-operated relay will cause the make-up valve to open and allow water to flow from the feed tank into the condenser, where it is immediately de-aerated before entering the circuit.

An alternative solution is to make the feed tank itself part of the condenser in the so-called "internal capacity" system; this system is shown in Fig. 5. A large well is arranged in the base of the condenser and the water level is allowed to rise and fall with load variations so that the boiler demands are met by the volume of water contained in this well. A make-up valve is fitted at a predetermined level to ensure that losses in the system are made up and also to return to the system all the drain water from feed heaters, &c. This arrangement has now been used in actual practice in several marine installations, and has given a very stable and smooth operation, and has proved itself to be an excellent solution of a somewhat difficult problem.

The closed feed system naturally depends for its success as a prevention against corrosion on the efficiency of the condenser as a de-aerator; in this respect some condensers are good and some bad. Good condensers are those which deliver their condensate at approximately vacuum temperature, and should give a condensate containing oxygen to the extent of not more than 0·05 cubic centimetres per litre. This leads to the question of de-aeration. Feed water can be de-aerated if the water be boiled and this can be done at any pressure and temperature. The first apparatus to make use of this fact was the "Weir" direct contact heater. This heater works in conjunction with a simple type of open-feed system; the simplest form of this type of installation is that with which the majority of steamships are equipped, and is shown in Fig. 6. In this case the feed water is passed from the open feed tank through a spray valve into a chamber where it mixes with exhaust steam. The pressure in the chamber is maintained close to the equivalent boiling point of the mixture by a small connection to the condenser, through which the liberated air is withdrawn. A water level is maintained in the base of the chamber by means of a float which in the case of water-tube boilers controls the delivery of water from the feed tank into the chamber as shown. In the case of tank boilers where the boiler itself forms the reservoir which compensates for the varying distribution of water in the circuit, the float controls the feed pumps and pump drawing from the feed tank is itself controlled by a float in the feed tank, which in this case may be of very small capacity. Fig. 7 shows in more detail the construction of the direct contact feed heater and de-aerator. This is substantially the same as in the original design first fitted in 1887. As the water in the base of the feed heater is close to the boiling temperature corresponding to its pressure it is necessary that the feed heater should have a considerable static head over the feed pumps so as to prevent vaporisation when passing through the pumps. In actual practice an elevation of 30ft. at least is desirable. This is in some cases a difficult requirement to meet, and it also entails the provision of a special pump to elevate the water to the heater. In the arrangement of Fig. 6, if it is undesirable to introduce a float-operated valve between the feed pump and its main reservoir of water, *i.e.*, the feed tank, the float control may be dispensed with and the chamber in the base of the heater made large enough to carry all the reserved water necessary. This, of course, entails a large elevated tank of hot water which requires to be insulated to prevent heat loss, and must be made sufficiently strong to withstand variations of pressure both above and below atmospheric.

As the water in a direct-contact heater is never actually boiling when the heater is working smoothly, the degree of de-aeration obtained is not as high as is possible. This is particularly the case at relatively low temperatures, say, 120 deg. to 130 deg. Fah.; at high temperatures, however, say, 200 deg. to 220 deg. Fah., the de-aration is quite satisfactory. This deficiency of the direct-contact heater at low temperatures can be overcome in special plants for de-aeration of which there are many designs. Fig. 8, shows the Weir "Optimum" de-aerator, which embodies the results of recent research on this problem. This apparatus is based on the principle that the efficiency of de-aeration is increased by the rapidity of boiling. The water enters at A and passes through the butterfly control valve B under the control of the float C; after passing through B the water is sprayed into the top of the chamber D by the spray nozzles E, falls down over the float C and collects in the compartment F; thereafter it passes through the port G and enters the compartment H; here it meets with low-pressure steam which enters at J and passes through a perforated plate K; this results in violent boiling taking place in the compartment H; the steam generated passes upwards and through the ports L and is condensed by the cold spray falling from the nozzles E. The water then passes round the compartment H and descends the port M to the suction of the water extraction pump N. The liberated air passes upwards through the cold sprays and is withdrawn at P either by an air ejector or by its connection to a condenser. This de-aerator works extremely well and gives very efficient de-aeration either at high or low temperatures, characteristic performance figures being 0·02 cubic centimetre per litre with inlet water at 126 deg. Fah. and outlet water at 150 deg. Fah., and 0·02 cubic centimetre per litre with inlet water at 47 deg. Fah. and outlet water at 100 deg. Fah. Its operation is entirely automatic, *i.e.*, the steam and water quantities can vary independently without affecting the stability of the plant; the only change these variations cause is that of the vacuum in the apparatus. This de-aerator is also a heater and can be placed at any convenient point in the feed circuit, one convenient arrangement being shown in Fig. 9. The water is drawn into the de-aerator by the vacuum therein, while a water extraction pump withdraws from the de-aerator and delivers under a light pressure to the feed pump suction.

In order to increase the thermal efficiency of any practical feed cycle various arrangements of feed heaters may be incorporated. Fig. 10 shows a common arrangement having one stage of exhaust steam heating and two stages

Fig. 7.

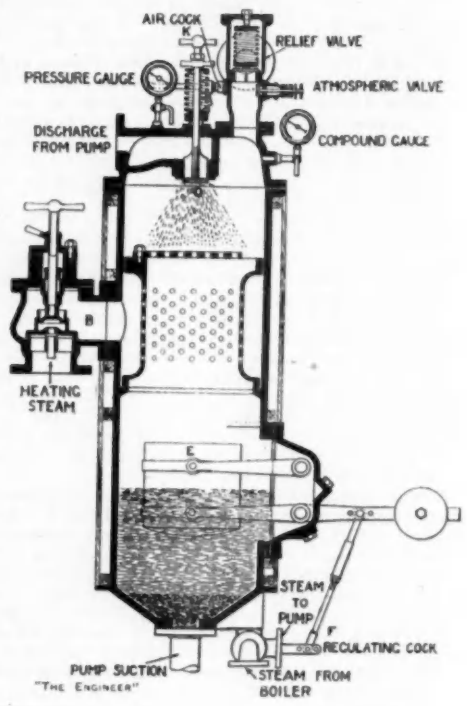


Fig. 2

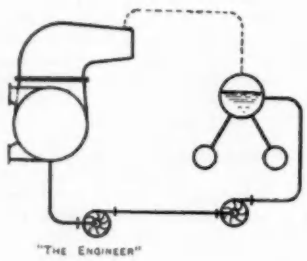


Fig. 3.

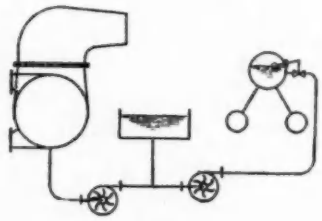


Fig. 4

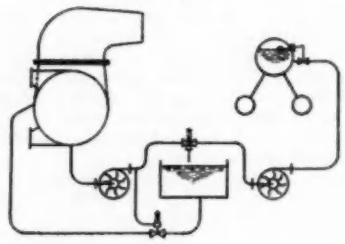


Fig. 5.

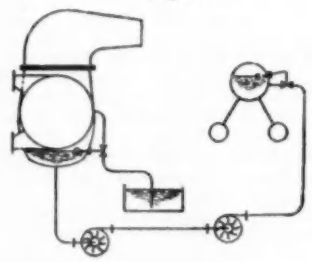
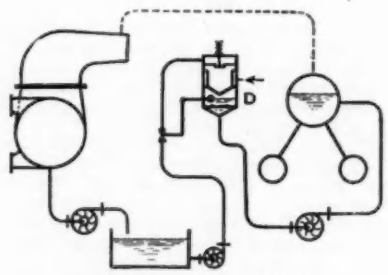


Fig. 6.



D. Direct-Contact Heater.
"THE ENGINEER"

* The Institution of Mechanical Engineers.

of bled steam heating. A shows the exhaust steam heater, which is placed between the condensate pump and the feed pump; this heater takes all the available auxiliary exhaust. By selecting the correct number and kinds of auxiliaries to be steam driven the quantity of auxiliary exhaust can be arranged to give an outlet feed temperature from this heater of about 160 deg. Fah. to 170 deg. Fah. These temperatures should be taken as a maximum for smooth and efficient working of the feed pumps at full load; at reduced loads the heater outlet temperature rises, but owing to the reduction in quantity passing the feed pump the latter deals with the hotter water quite smoothly. Under such conditions Weir turbo feed pumps on a closed feed system have dealt with water at up to 220 deg. Fah., but such a high temperature on a feed pump suction is not to be generally recommended. The two bled steam heaters are placed on the discharge side of the boiler feed pump and are in series on their water side. These heaters consequently have to be of heavy construction to withstand the pump discharge pressure and are thus expensive. The heater or heaters on the suction side are low-pressure heaters and have the advantage of cheapness. For cost considerations, therefore, and consistent with good working of the feed pump, as much heating surface as possible should be placed on the suction side of the feed pumps. The pressures at the bled points should be so chosen that the saturation temperature of the steam should be about 10 deg. Fah. higher than the outlet feed temperature from the heater. This temperature difference gives a reasonable size of heater with good economy. Some of the larger American power stations, however, have this temperature difference as low as 5 deg. Fah. For any given condition it is, of course, easy to determine the correct compromise between the capital cost and the thermal efficiency of the heaters. In marine installations, for example, a terminal difference of 20 deg. Fah. is more commonly used.

In order to get the best heat balance it is necessary that the lay-out diagram should also include the combustion air circuit. Fig. 11 shows a feed circuit combined with a combustion air circuit, the latter having an air preheater and an economiser. E is the air preheater and D the economiser. Since an economiser is fitted fewer bled steam heaters would be used. The outlet feed temperature from heater C as before would be about 220 deg. Fah., and the outlet feed temperature from the economiser would be about 400 deg. Fah., the air temperature leaving the heater would be 380 deg. Fah., and the final temperature of the flue gases leaving the air preheater would be 300 deg. Fah.

Another important influence on the feed circuit is the make-up feed. This is generally supplied by the evaporation of raw water at a suitable pressure datum. The decision of the correct pressure datum to employ depends upon the particular circumstances of the lay-out. It is, however, generally preferable to have the datum low down on the temperature-pressure curve. This is advantageous primarily because of the soft scale which results from low-temperature evaporation and from the relatively larger temperature differences at the low end of the scale. This may be seen by considering the comparative temperature differences at, say, 100 lb. per square inch gauge steam pressure and, say, 5in. vacuum; for a 5 lb. per square inch pressure difference in each case the comparative temperature differences are 11 deg. Fah. and 24 deg. Fah. This means that for the same transmission rate in each case the low-pressure evaporator need only have a surface 11/24ths of that of the high-pressure evaporator; owing to the smaller transmission rate normally obtainable at low pressures this is not strictly true, but even when the lower transmission rate is allowed for the surface reduction permissible is very considerable. It is occasionally found when working out heat balances that too much exhaust steam is available; in such cases the multiple-effect evaporator is advantageous. This evaporator may be double, triple, or quadruple, or even sextuple effect, the latter two being primarily suited for the higher steam pressures. The ratio of production to steam used from the multiple-effect evaporator is approximately as follows:—

Simple effect	0·8 to 1
Double effect	1·3 to 1
Triple effect	2·6 to 1
Sextuple effect	4 to 1

It is, however, only rarely that anything more than double effect is necessary for normal power plants. Fig. 12 shows a typical feed system having a low-pressure evaporator incorporated in the scheme; this is, in fact, the actual scheme adopted on the new P. and O. liner "Viceroy of India." A is a drain cooler, B a low-pressure heater, C an intermediate-pressure heater, D a high-pressure heater, and E the low-pressure evaporator. The prevailing temperatures at the various points are indicated on the figure. It will be noted that the evaporator takes steam from the turbine at a pressure of 22·2 lb. per square inch absolute, the vapour passing into the lower bled steam range at a pressure of 8·5 lb. per square inch absolute. These pressures give a temperature difference of 48 deg. Fah., which is quite moderate, and the shell pressure, which is only 8·5 lb. per square inch with a corresponding temperature of 106 deg. Fah., should give a very soft scale. Coupled with the fact that the feed water entering the evaporator is fresh water drawn from the double bottom, the arrangement should result in a make-up free from all impurities. The heater drain system should be noted; the heater D drains to C, C to B, and B to A, and A to the main condenser. This arrangement allows the heat in the drain to be imparted to the feed water at a high heat datum which is conducive to efficiency. All water therefore passes through the condenser once in every cycle; consequently, since the system is closed, there is a cumulative de-aeration effect. The pressures at which steam is bled for the heaters may be noted, B taking steam at 8·5 lb. per square inch, C at 22·2 lb. per square inch, and D at 77 lb. per square inch, while the final feed temperature is 300 deg. Fah., the boiler pressure being 375 lb. per square inch. It is also interesting to note that the steam for galley purposes is taken from the first bled steam range at 77 lb. per square inch pressure.

An alternative method of producing make-up working fluid is to introduce specially arranged boilers for this purpose. This method has considerable advantages in high-pressure installations with high superheat as regards the steam supply to the auxiliaries. A recent arrangement of this type applied to important modern vessels is due to Mr. J. J. Johnson, of Canadian Pacific Steamships, Ltd., and is a composite arrangement of high-pressure water-tube boilers for supplying high-pressure high-temperature steam to the main propelling engines with medium-pressure Scotch boilers for supplying saturated steam to the auxiliaries. The boiler pressures are 370 lb. per square inch and 200 lb. per square inch respectively for the high and low-pressure boilers. The arrangement is shown in Fig. 13; it will be seen that the system is open with the normal type of direct-contact heater fitted, this heater being supplied with steam from the turbo-generator. The method of introducing the make-up for the high-pressure boilers is as follows. The make-up for the Scotch boilers is pumped from the reserve tank into the Scotch boilers in the usual way; steam is fed to the intermediate-pressure receiver through a reducing valve from the Scotch boilers through the pipe A. This steam does work in the intermediate-pressure and low-pressure turbines; the resulting condensate accumulates in the feed tank. The water level in the latter consequently rises till the overflow is reached, and the surplus flows back to the auxiliary feed tank for the Scotch boilers through the pipe B. Two heaters are employed, a low-pressure heater C and a high-pressure heater D. The low-pressure heater C takes all the auxiliary exhausts and drains to the auxiliary feed tank, while the high-pressure heater D takes steam from the Scotch boilers and drains to the main hot-well; the drain augments the steam supply from the Scotch boilers to the intermediate-pressure receiver for make-up purposes for the high-pressure main system. It will be noticed that no condensate from the low-pressure system, which may contain grease from the auxiliaries, is allowed to pass to the high-pressure system. This is a most important feature. On trial the temperature of the feed leaving the high-pressure heaters was as high as 320 deg. Fah., and the economical running of the vessels concerned is well known.

Wide fluctuations in load adversely affect the performance of a boiler plant, and for this reason various forms of heat accumulators have been devised for insertion in the feed circuit. The principle involved is that of storing heat in a large quantity of water under pressure and at saturation temperature, and releasing this energy in the form of steam under decreasing pressure. Fig. 14 shows a Ruths steam accumulator arranged in the normal feed circuit for an industrial plant where a proportion of the steam is used for electrical generation and the remainder for process work. The two valves indicated, one on either side of the steam connection to the accumulator, are so arranged that the pressure in the process steam range is constant. When the steam supply is in excess of requirements the valve A opens and admits high-pressure steam to the accumulator, causing an increase in pressure in the accumulator. At peak loads steam will be drawn out of the accumulator, causing the pressure therein to fall, at which time the valve A will be shut. Valve B controls the steam passing to the process range, and is automatically operated, as is also valve A. The control valves A and B are actuated by servo-motors operated by oil pressure under the control of pilot valves and relays, which are in turn controlled by the pressure to be regulated. The oil pressure is maintained by a suitable pump. The accumulator is simply a large cylindrical tank with hemispherical ends. The water occupies about 90 per cent of the volume and the heating is carried out by direct contact, suitable nozzles for this purpose being arranged along the whole length of the accumulator to prevent undue noise and to give uniform heating.

Condensed process steam is not always recoverable, but where it is there are several methods of reintroducing it to the main feed circuit. In this instance it is de-aerated and heated in a suitable de-aerator before combining with the condensate from the turbine plant. In the arrangement just described the accumulator provides steam at a lower datum than occurs in the boiler, but steam at boiler datum may need to be held in storage.

Fig. 15 indictaes how this may be accomplished. The accumulator is in direct communication with the boiler steam drum and the water in the accumulator is taken from the boiler water drum, a pump being provided to give the water the required head and to maintain circulation. Since the pressure in the accumulator and steam drum is the same no control valves are required.

With high initial steam pressure the steam becomes unduly wet long before the condenser is reached, and in consequence erosion troubles and general loss of efficiency due to wetness may be encountered in the low-pressure blading. It therefore becomes convenient to take the steam at a suitable stage of expansion and to reheat it, and in this manner to move the dew point farther along the steam path towards the condenser. Apart from eliminating erosion troubles, &c., in the turbine blades, this arrangement has a definite thermodynamic advantage and increases the efficiency of the cycle. In Fig. 16 this

Fig. 8.

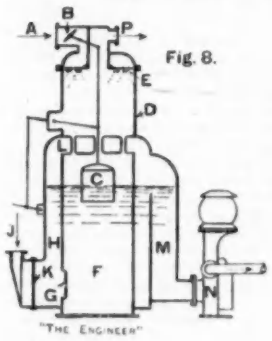
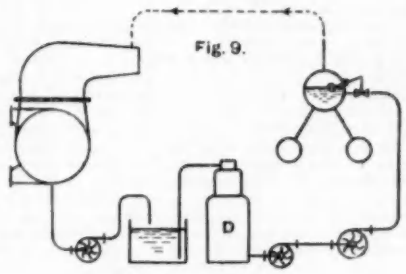


Fig. 9.



D De-Aerator.

Fig. 10.

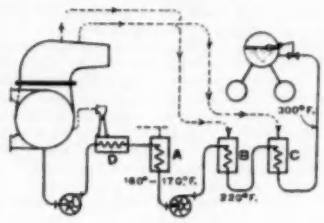


Fig. 11

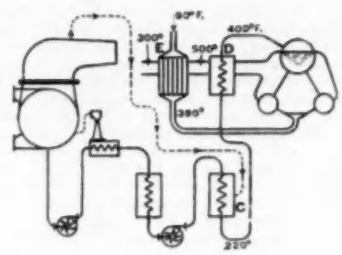


Fig. 12

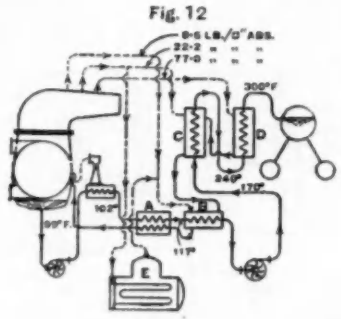
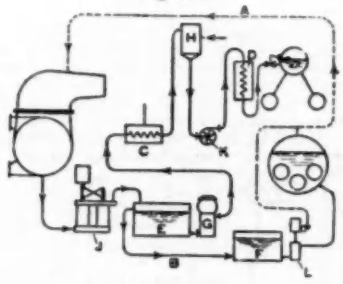
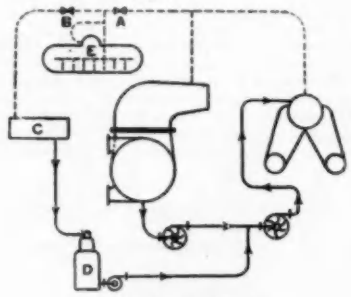


Fig. 13.



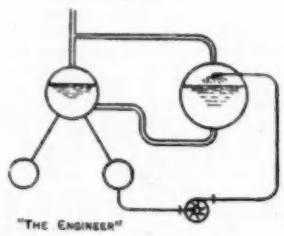
E. Feed Tank.
F. Auxiliary Feed Tank.
G. Hot Well Pump.
H. Direct-Contact Heater.
J. Air-Pump.
K. Feed Pump, Centrifugal.
L. Feed Pump, Direct-Acting.

Fig. 14.



C=Process Plant.
D=De-Aerator.
E=Ruths Accumulator.

Fig. 15.



reheating is obtained by leading the exhaust steam from the first turbine back into a series of heating coils arranged on the outside of the superheater, the heating medium being, of course, the flue gases.

In Fig. 17 the reheating is effected by means of superheated steam at full boiler pressure; the reheater in this instance may be arranged in any suitable position, and consequently this system has a wider field of application.

In Figs. 16 and 17 it will be noted that the reheat steam forms a sub-circuit, and similar sub-circuits may be applied to generate steam at extra high pressure.

Fig. 18 shows such an arrangement where water is drawn off from one of the low-pressure boiler drums and pumped into the high-pressure boiler, which is simply an element of small bore tubes arranged in coils and accommodated under the tube banks of the low-pressure boiler. A represents the high-pressure boiler element. Since these coils are directly exposed to radiant heat the maximum transmission rate will be obtained, and as the coils are composed of very small-bore tubes, the highest pressure can be maintained in the high-pressure boiler. The steam produced in the high-pressure boiler is thus suitable for use in an extra high-pressure turbine, the exhaust from which can cascade into the turbine supplied with steam from the low-pressure boiler. In this manner the initial temperature datum for a portion of the working fluid is considerably higher than normal, and the thermal efficiency of the plant as a whole is thereby increased. The high-datum steam supply is drawn off through the valve B, and a spring-loaded circulating valve C is fitted to ensure a continuous circulation within the high-pressure element A under all variations of steam quantity passing through the valve B.

The use of boilers at two pressures in a combined circuit has recently become fairly common, and in this way it is possible to modernise existing plants by superimposing high-pressure boilers cascading into them.

Fig. 19 shows in diagrammatic form such an arrangement. From the water drum of the existing boiler a connection is taken to the boiler feed pump serving the high-pressure boiler. The steam produced in this boiler is expanded in the high-pressure turbine to the pressure datum obtaining in the existing turbine, and then mixes with the steam produced by the existing or low-pressure boiler. On the diagram the existing boiler pressure is indicated as being 350 lb. per square inch, and the pressure with the added high-pressure boiler as being 1200 lb. per square inch. These figures are representative of actual practice.

To obtain the full thermal advantage of polytropic steam generation it is, however, necessary to put the boilers in series also on the flue gas side. The high-pressure boilers are preferably of the water-tube type and the low-pressure boilers of the capacity type.

Fig. 20 illustrates two water-tube and one capacity type boiler arranged to give polytropic steam generation. On both steam and flue gas sides the boilers are arranged in series. With this arrangement no air preheaters are required, as the low-pressure boiler will reduce the flue gas temperature to the same level as in a normal air preheater. Similarly no economisers are required, but single-stage regenerative feed heating can, if desired, be incorporated in the system. The feed water for the intermediate and high-pressure boilers is taken from the low-pressure and intermediate-pressure boilers respectively; pumps for this purpose are indicated on the diagram. The low-pressure boiler is fed in the normal manner with condensate.

The arrangement of boilers in series at varying datum is an alternative to the more common scheme incorporating a single high-pressure boiler with air preheater, economiser, and multiple-stage feed water heating.

A Schmidt boiler as shown in Fig. 21 is of the type referred to above. The tube element A is exposed to the radiant heat from the fire F, and the steam formed passes to the tube element B inside the boiler drum C. Here the heat in the steam inside the tubes is transferred to the water in the drum, which is evaporated and passes to the high-pressure turbine after being superheated in the superheater element D. The water inside the tubes of the element A is chemically pure and de-aerated, and the circuit is hermetically sealed. This ensures that the portion of the heating surface of the boiler which has the most onerous duty to perform, i.e., to absorb the radiant heat, has the necessary protection against corrosion and other deleterious action. The boiler is provided with an economiser E, and the reheating of the steam after expansion in the high-pressure turbine is carried out in the reheater G, which is supplied in the usual manner with superheated high-pressure steam. A pump returns the condensed high-pressure steam to the boiler drum C. In the sub-circuit of distilled water passing through the tube element A exposed to the radiant heat and the tube element B inside the boiler drum C the circulation is entirely dependent on a thermo-syphon, and no pump is therefore installed.

When the fundamental conditions of maximum efficiency in a steam cycle are investigated it is clear that steam is not entirely suitable as a working fluid. Various alternatives have been tried, the most successful being the superimposing of a mercury circuit on a steam circuit. Fig. 22 illustrates such a binary-fluid cycle. The mercury is evaporated in the mercury boiler A, the heat being supplied from the fire B. The mercury vapour is expanded in the mercury turbine C and passes to the mercury condenser D, which also functions as the steam boiler. In condensing the mercury vapour the feed water for the steam cycle is evaporated, and the steam formed is led to the steam turbine E and ultimately is condensed in the steam condenser F; this condensate forms the cooling medium in the mercury condenser D and thus the circuit is completed. Extraction pumps and feed pumps are required for both mercury and steam circuits, and although not shown on the diagram, the mercury boiler is complete with economiser and air preheater, as in a normal steam boiler; but on account of the high saturation temperature of the mercury vapour no mercury superheater is installed. The steam, however, is passed through a superheater element before passing to the turbine.

The binary-fluid system as described generally above has already been tried in a mercury turbine developing 1200 kW with results sufficiently encouraging to warrant the construction of a larger unit of 20,000 kW. This set, which consists of a 10,000-kW mercury turbine and a 10,000-kW steam turbine, is estimated to have an overall thermal efficiency of 32·5 per cent., which compares favourably with the best Diesel performance. It is claimed that a modern steam station with a boiler pressure of 350 lb. per square inch can have its thermal efficiency increased by 50 per cent. by the addition of a mercury vapour installation.

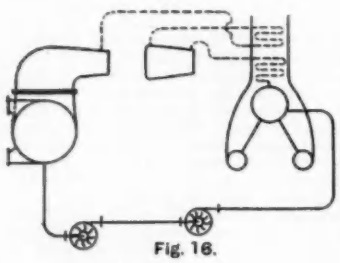


Fig. 16.

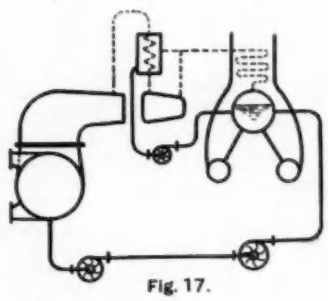
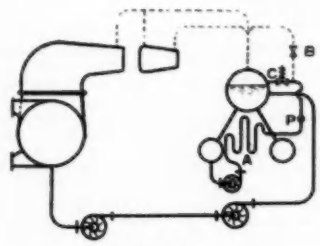


Fig. 17.



P. Pyrometer.

Fig. 18

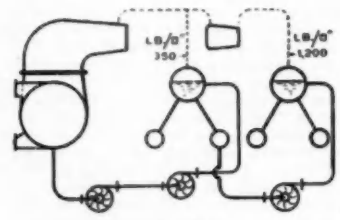
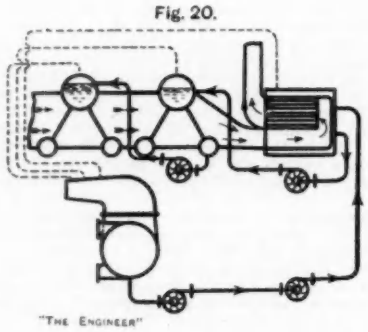


Fig. 19.

Fig. 20.



"THE ENGINEER"

Fig. 21

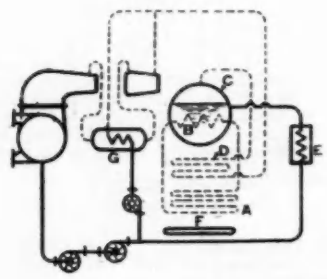
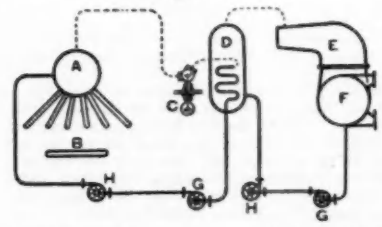


Fig. 22



A = Mercury Boiler.
B = Fire.
C = Mercury Turbine.
D = Mercury Condenser and Steam Boiler.
E = Steam Turbine.
F = Steam Condenser.
G = Extraction Pumps
H = Feed Pumps.

L.M.S.R.—HIGH-PRESSURE LOCOMOTIVE.

WE are now at liberty to make the announcement that the London, Midland and Scottish Railway has decided to make an effective test of the Schmidt system of generation of high-pressure steam in locomotives. In our issue of January 20th, 1928, we described fully, with detail drawings, a locomotive for the German State Railways built on this plan, and we need only recall here that the high-pressure steam is raised in a drum, separated from the normal boiler, by the passage of very hot steam through tubes which pass through the drum. The steam within the tubes is generated in a water-tube fire-box. The steam from the drum is first used in a high-pressure cylinder at about 900 lb. pressure, and is then mixed with low-pressure steam from the boiler and used in two low-pressure cylinders at 250 lb. per square inch. Since the feed water all passes, in the first place, through the low-pressure boiler, all deposition takes place there and no trouble with scaling can occur in the high-pressure drum. The water in the heating tubes is distilled, and is in a closed circuit; consequently no scaling or internal corrosion can occur.

The L.M.S. engine, which is to be fitted with a boiler of this type, will be of the "Royal Scot" type. It will be built by the North British Locomotive Company, Ltd., under the supervision of Sir Henry Fowler, chief mechanical engineer of the L.M.S. Railway, and the Superheater Company, Ltd., of London. The latter company is responsible for the general design, covering the high-pressure boiler, and as the engine will be a three-cylinder compound type, certain modifications will be required to the inside cylinder in accordance with the Superheater Company's proposals.

SIXTY YEARS AGO.

SOME interesting comments on the progress of aeronautics and on the possibility that flying machines might in time become "things of the day," are to be found in our issue of January 22nd, 1869. Our notes were based on an article contributed to the "Popular Science Review," by Mr. F. W. Brearey, honorary secretary of the Aeronautical Society of Great Britain. In the summer of 1868 the Society had held an exhibition at the Crystal Palace of models and plans connected with the science of aeronautics, and in his article Mr. Brearey undertook to explain the nature of the principal exhibits. Incidentally he revealed the state of knowledge concerning aeronautics reached at that time, and of the direction in which scientific people were endeavouring to attack the problem of mechanical flight. At that date and for many years afterwards, until indeed the time of the brothers Lilienthal, workers in this field were largely obsessed with the idea that if man were to fly, he would have to copy the birds and insects, if not in the matter of providing a machine with flapping wings then at least as regarded the proportions between the lifting surfaces and the weight lifted. Something like a shock had, however, recently been given by Monsieur de Lucy, of Paris, to the followers of the birds. Monsieur de Lucy had presented a paper before the Aeronautical Society, in which he asserted that his study of birds and insects had led him to the discovery of what appeared to be a rigorous law of nature, namely, that the smaller and lighter the winged creature the greater was the comparative size of its wings. He pictured the mathematician endeavouring to work out the sustaining surface of a man-lifting flying machine from observations made on the swallow's weight and surface. He would find that to obtain a lift of 165 lb. he would require a surface of 116,250 square inches. If, however, he took the pigeon as the basis of his calculation, he would find that to lift the same weight he would require a surface of only 31,000 square inches. On the other hand, if he calculated from the size and weight of the butterfly, he would arrive at a surface so great that its construction and manipulation would be impossible. How hopeless it was to follow the birds and insects in this matter of determining the area of the lifting surfaces required is revealed at once by a study of the dimensions of a modern aeroplane. A recent design of two-seater light aeroplane has a wing area fairly near to that calculated by Monsieur de Lucy from his measurements of the pigeon—to be exact, its wing area is 34,560 square inches. Fully loaded it develops a lift of 1680 lb., or ten times as much as the pigeon basis indicates.

B.E.S.A. SPECIFICATIONS.

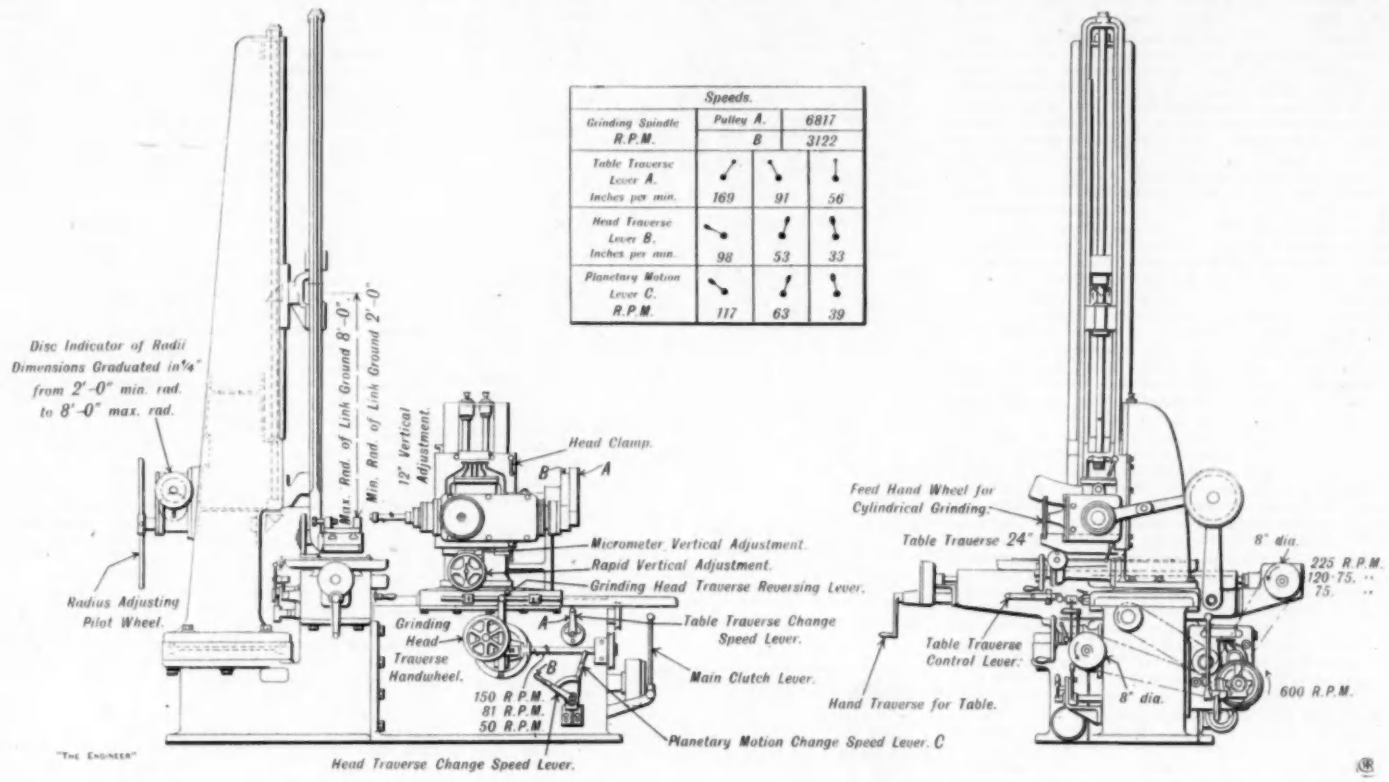
BRASS SHEET AND STRIP.

THE British Engineering Standards Association has recently issued revised British standard specifications for three qualities of brass sheet and strip, which supersede the specifications first issued in 1926. The numbers of the specifications and the grades covered are as follows:—No. 265—1928, 61/39 brass sheet and strip; No. 266—1928, 65/35 brass sheet and strip; No. 267—1928, soft cartridge brass sheet and strip.

The principal modifications which have been made to the specifications are the addition of tolerances on the thicknesses of wide sheets, the revision of certain of the requirements connected with the measurement of these tolerances, the mechanical tests and the tests for hardness and ductility. Copies of the revised specifications may be obtained from the publications department of the British Engineering Standards Association, 28, Victoria-street, Westminster, S.W. 1, price 2s. 2d. each post free.

GRINDING MACHINE FOR LOCOMOTIVE PARTS

BEYER, PEACOCK AND CO., LTD., MANCHESTER, ENGINEERS


Speeds.
Grinding Spindle R.P.M.
Pulley A. 6817
B 3122
Table Traverse Lever A. Inches per min. 169 91 56
Head Traverse Lever B. Inches per min. 98 53 33
Planetary Motion Lever C. R.P.M. 117 63 39
Disc Indicator of Radii Dimensions Graduated in ¼" from 2'-0" min. rad. to 8'-0" max. rad.
Max. Rad. of Link Ground 8'-0"
Min. Rad. of Link Ground 2'-0"
12" Vertical Adjustment.
Head Clamp.
Micrometer Vertical Adjustment.
Rapid Vertical Adjustment.
Grinding Head Traverse Reversing Lever.
Table Traverse Change Speed Lever.
Main Clutch Lever.
Planetary Motion Change Speed Lever. C
Head Traverse Change Speed Lever.
Radius Adjusting Pilot Wheel.
Grinding Head Traverse Handwheel.
150 R.P.M.
81 R.P.M.
50 R.P.M.
Feed Hand Wheel for Cylindrical Grinding.
Table Traverse 24"
8" dia.
225 R.P.M.
120
75
Table Traverse Control Lever.
Hand Traverse for Table.
8" dia.
600 R.P.M.
"THE ENGINEER"

A Hacksaw Factory.

THE illustration which we reproduce below shows the interior of a new machine shop which has been built by James Neill and Co. (Sheffield), Ltd., of Composite Steel Works, Napier-street, Sheffield, for the manufacture of Eclipse hacksaw blades and frames.

This room is on a level with the first floor of the existing hacksaw department, and reaches out over a portion of the ground floor premises occupied by the crucible furnaces. It is constructed with fireproof materials, the floor being of reinforced concrete. The roof, it will be seen, is supported by trusses, which have unusallly substantial tension members, with the object of enabling them to carry line shafting. On one side the roof consists of patented glazing with wire-wove glass along its entire length. The other side is lined with beaver boarding, which acts as an efficient reflector in throwing the light downwards on to the machines. The windows are steel

framed with Arctic glass, and are fitted with ventilating hoppers and centre hung casements.

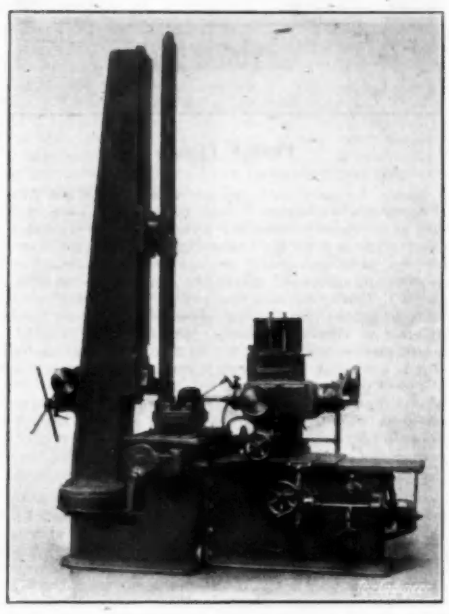
A feature of the new shop is the labour-saving lay-out adopted. It was considered impracticable to adopt a conveying system, because of the great variation in the sizes of hacksaw blades, so a system of special racks and trays, made to standard measurements, was adopted in order that the blades could be accommodated without trouble or waste of space close to each machine. For each operation the blades are so arranged as to give the operator complete control of the work being done, and great care has been taken to make the operator as comfortable as possible in order to minimise fatigue and monotony. As will be seen from the engraving, ample gangway space has been provided for the passing of specially designed trolleys for carrying the blades in their varying stages of production from one process to another. Heating is provided by means of low-pressure hot water, the pipes being fitted close to the floor. The extension has been decorated and painted in bright colours, which, with the excellent lighting, gives a most cheerful effect. Mess room accommodation for the operators has also been provided.

THE Chinese Government proposes to initiate a service of aeroplanes between Nanking and Kalgan.

Grinding Machine for Locomotive Parts.

THE illustrations on this page represent a machine designed and built by Beyer, Peacock and Co., Ltd., Manchester, for grinding locomotive parts, such as cylinders, liners, or details which, owing to their shape, cannot be conveniently rotated. It also embraces a pendulum grinding attachment for dealing with the slot and holes in expansion links. At the rear of the bed are the driving drum and the gear-box, the latter being designed to give three speeds to the upright and table traverse and planetary motion. The gearing in this box is driven by a single-belt pulley through the medium of a friction clutch of the hand-operated toggle lever type.

Mounted on the bed and having automatic traverse



GRINDING MACHINE

thereon is an upright which carries the spindle slide, the traverse being controlled by a reversing motion operated by adjustable stops which are arranged to pass the reversing lever without disturbance when desired. The traverse is also provided with a hand-operated motion. The spindle slide is fitted at the front of the upright, and the spindle, of large diameter, runs in ball journal bearings and a taper bronze bearing. When using large grinding wheels a rigid snout bearing for supporting the arbor is fitted. The drive for the spindle is taken from the drum at the rear of the machine through a two-speed intermediate shaft, and a tension device is provided for the belt. A hand wheel having micrometer and coarse feed movements controls the slide on the upright.

The drive for the planetary motion is obtained from the gear-box mentioned above through gearing to a helical gear on the spindle barrel, thus ensuring smoothness of running. For feeding the spindle toward or away from the work when grinding holes the inner sleeve is provided with simple mechanism of the inclined-plane type which is operated by a hand wheel on the outside of the front cover.

The body on which the work table is mounted is rigidly fixed to the bed of the machine. The table is fitted with an automatic traverse controlled by a sensitive reversing motion operated by adjustable stops, and is provided with T slots and water trough. In addition to the power motion the table can be adjusted by hand. On the circular portion of the bed the link motion upright is mounted in such a manner that it can be swung round to leave the table clear. This upright is fitted with a screw which is operated from a hand lever through gearing and a nut fixed in a slide carrying the pivot bracket that supports the radius bar, the bar being provided with a screw which is operated by the upright screw through gearing. In order to ensure that the radius which is being ground does not vary as the pendulum swings from side to side, a special compensating device is fitted into the gearing used for setting the radius.

Attached to the radius bar is the link table, which is traversed by means of a pivoted slide block, and in order that the operator can set the required radius without moving from the hand lever, a graduated disc, connected by suitable gearing to the lever, is fitted. All the gearing is machine cut and runs in oil wherever possible, while all the high-speed shafts run in ball bearings.

The following are the principal dimensions of the machine :—

Table surface	3ft. by 1ft. 3in.
Traverse of table	2ft.
Link table	2ft. by 8in.
Minimum and maximum radius ground	2ft. and 8ft.
Maximum excentric stroke of spindle	2in.
Vertical traverse of spindle	1ft.
Longitudinal traverse of upright	1ft. 8in.
Number of upright traverse speeds	Three
Number of table traverse speeds	Three
Number of planetary motion speeds	Three
Number of spindle speeds	Two
Capacity of machine	Will grind holes ⅞in. by 3in. deep and upwards
Size and speed of driving pulley	10in. dia. by 3¼in. wide, 600 r.p.m.
Floor space occupied	10ft. 6in. by 8ft.
Power required	6 H.P.
Approximate net weight	90¼ cwt.
Approximate gross weight	107½ cwt.

Two further instances of accidents to trains in which there were gas-lighted vehicles, but no subsequent fire, may be added to the list given in our leading article of November 30th last. In his report on the Darlington collision of June 27th, Sir John Pringle reported that no fire occurred as a result of this collision. The first coach alone was lighted by gas, and no breakage took place of high-pressure gas piping or perforation of the gas cylinders carried on the coach. Then, as to the New Tredegar Colliery accident on October 9th, Colonel Mount said that the passenger train was lighted by gas and the cylinders of its seven coaches were undamaged, but gas escaped from the first two coaches through fractures in the pipes. It is important to note that it is remarked that the provision of automatic safety valves for isolating the cylinders, in the event of pipes becoming broken, would presumably have prevented the escape which occurred in that case, but it is not, Colonel Mount understands, the practice of the Great Western Company to fit such valves.

Further Progress in Crystal Analysis.

IN a discourse delivered at the Royal Institution on January 18th Sir William Bragg said that alloys have played a great part in the history of mankind. The qualities of pure metals are rarely desirable, but the properties of alloys cover a far wider range within which can be found every variety of usefulness. Pure copper is too soft for most purposes, but when varying quantities of tin are introduced, the bronzes so formed have many applications. At one stage of human development, bronze was all-important. It is still largely used. The copper coinage is only slightly alloyed; the useful "gunmetal" contains a larger quantity of tin, bell metal contains more, and speculum or mirror metal more still. Small quantities of other substances, specially zinc, are often inserted into bronzes; and the influence of minute quantities of such foreign substances is remarkable. Since many substances can be used in making alloys, two or more at a time, and since even minute quantities of a component often change the properties entirely, it will readily be understood that the possible variations are almost infinite. Among these metallurgists seek for those which can be put to practical use. Great advances have been made in recent years; and such terms as chrome steel, manganese steel, duralumin, and the like have become common.

The reasons for this variety are most obscure, and great interest attaches to any method which can help to bring order and understanding into the complexity. The X-rays have come to give assistance of a novel kind. They reveal the modes in which the atoms are arranged in solid substances, provided that any regularity of arrangement exists; and, in general, this is the case. It turns out that the atoms in the different phases of a mixture are put together, according to different patterns; and the properties of the substances are obviously connected with the pattern. In pure copper the atoms are piled together in close packing, like spherical shot; each sphere then touches twelve neighbours. When a small number of zinc atoms are added they distribute themselves at random amongst the copper atoms without disarranging the pattern very much. But there is a limit to this addition. If too much zinc is put in, a new pattern, in which each atom now has only eight neighbours is formed. Next comes a remarkable change, as more zinc still is put with the copper. A very complicated pattern is formed, of which the unit is twenty-seven times as large as in the preceding case, and there are fifty-two atoms in it. This alloy is very hard and brittle. Curiously enough, there is an alloy of copper with aluminium, and again of copper with tin, in which the same properties are exhibited, the same pattern is found, and the same number of atoms in the pattern. Moreover, what is still more interesting is that there is the same number of free electrons. The free electrons are those which a metal can shed comparatively easily; a zinc atom can shed two, an aluminium atom three, and a tin atom four. These curious alloys are composed of five atoms of copper to eight of zinc, nine of copper, to four of aluminium, and the third—very approximately in the ratio of—thirty-one of copper to eight of tin. In each case there are thirteen atoms to twenty-one electrons.

These new and from all points of view most interesting results are due mainly to the work of Owen and Preston, Bradley, and Bernal in England, Westgren and Phragmen in Sweden. They open up new ideas of the conditions in the alloy. They suggest that we ought not merely to think of an alloy as a mixture of atoms, but in some cases at least as a mixture of electrons with atoms, the latter having considerable latitude as to nature.

Somewhat similar conclusions have been reached in regard to the silicates composing by far the major part of the earth's crust. We are getting away from the conception that the "molecule" of liquids and gases is generally to be found in all solids.

The lecture referred to other points of recent discovery.

A Chapter in the History of the Water Supply of London.*[1]

By RHYS JENKINS, Past President.

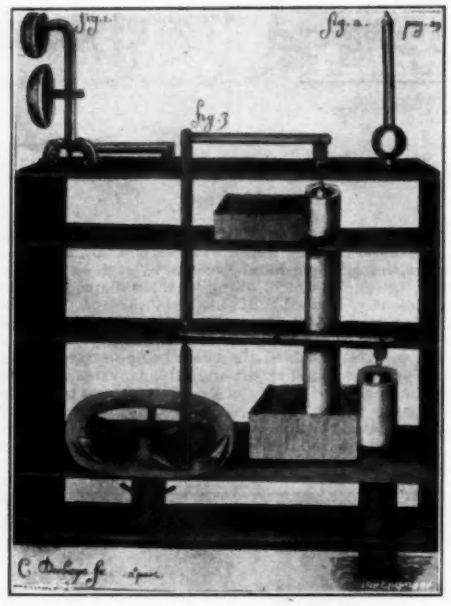
THE history of the water supply of London is a most interesting subject, and a very extensive one. This paper is confined to a particular chapter in that section of it concerned with supplies obtained by pumping direct from the river Thames, with an installation erected by Sir Edward Ford, during the period of the Protectorate of Oliver Cromwell, on the side of the river near Somerset House. Although it was not one of the earliest and had but a short life, an account of this waterworks is of interest for several reasons. Ford and his undertaking enter into the general history of the period, and we have a contemporary description and drawing of the pumps—not perhaps so full and accurate as we should like; moreover, the telling of the story affords an opportunity of bringing to notice the only Letters Patent for an invention granted by Oliver Cromwell that has come down to us.

In early times the Londoners got their water on the spot, from brooks and from wells sunk in the gravel. These local supplies were supplemented in the thirteenth century by water drawn from Marylebone and brought to conduit heads in the City by a pipe line. The population continued to grow and various schemes were propounded for increasing the supply of water. Then at the end of the year 1582 Peter Morrice had his pumps at London Bridge at work. He used force pumps worked by water-wheels set in an arch of the bridge and laid pipes in the streets, to which connections were made for some of the private houses. The undertaking was a great success, and from time to time additional pumps and water-wheels were erected. This success induced others to enter the field, among them the mining engineer, Bevis Bulmer, who set up works with chain pumps driven by horses at Broken Wharf in 1594. The site was off Upper Thames-street, about midway between Blackfriars and Southwark bridges.[2] Later on the works came into the possession of the New River Company, which, in 1824, set up a steam pumping engine there, it being thought wise to be in position to fall back upon Thames water in case the New River supply failed.

The New River supply dates from the year 1613; it is hardly necessary to say that it was a most valuable and important addition to the existing supplies; but London continued to grow and more and more water was required. Many projects were put forward to meet this demand and among them is that of Sir Edward Ford.

Clarendon refers to Sir Edward Ford as "a gentleman of good family and fair fortune in Sussex;"[3] he was the son of Sir William Ford, of Up Park, in the parish of Harting, Sussex, where he was born in 1605. He entered at Trinity College, Oxford, but did not take a degree. In 1640, when he was thirty-five years old, we come across him as the patentee of an invention [No. 138] "for the speedy passage and navigation of boats, lighters, and other vessells upon navigable rivers or the sea." This invention, the nature of which we do not know, may have been the means of turning his attention to the subject of water supply, for in the following year he issued a printed pamphlet entitled "A Design for bringing a Navigable River from Rickmansworth to St. Gyles in the Field; the Benefits of it declared, and the objections against it answered." Apparently a plan for another "New River" had been sanctioned, and Ford now proposed to make a canal for bringing water to London with the channel large enough for navigation. However, nothing came of either of these projects; for one thing, the Civil War intervened.

Ford took the side of the King, who made him a Colonel in his Army, and, later, conferred a knighthood upon him. Towards the end of 1642 he was holding the city of Chichester for the King. Chichester was besieged by Sir William Waller. Ford had to surrender and was made a prisoner, but was soon released. Little more than a year later he was again the prisoner of Waller; he had been placed in charge of Arundel Castle, which was besieged and taken by Waller. This time Ford was sent to the Tower of London, but in December, 1644, he contrived to escape to the Continent. In 1647 he was sent back to England by



FORD'S PUMPS

the Queen, to carry on some negotiation with the Army, and again made prisoner. Ford, however, had a powerful friend in the enemy camp, for he had married the sister of Ireton, who, it will be remembered, was son-in-law to Cromwell, so he was gently treated and the fines laid upon him were not enforced. No doubt after the death of King Charles I. (1649) he was persuaded by his wife and her friends to accept the existing state of affairs and became reconciled to Oliver Cromwell; at all events in 1655 he received the Letters Patent which is now to be considered, and it is said that it was upon Cromwell's encouragement that he set up his waterworks.[4]

The patent to Ford is one of perhaps a dozen patents for inventions which seem to have been granted by Oliver Cromwell as Lord Protector, but it is the only one the enrolment of which is to be found at the Public Record Office.[5] The document opens in the following terms:—

> Oliver Lord Protector &c. To all to whome theis presents shall come, greeting: Whereas wee have beene informed, that by the long studdy and much charge of Edward Ford of Harting in our County of Sussex Esquier, otherwise called Sir Edward Ford, a new and much better way is found out and discovered, then hath ever yett beene practized in this Comen Wealth, for dreyning of lands overflowed with water, watering of lands wanting water, supplying of water trenches for carrying and conveying of boates from place to place, rayseing of water to serve Citties or houses, as likewise for cleering, drayneing, and avoiding of springs and falls of water from Mynes of Silver and other Mettalls, Coles, Jett, and all quarries of Stone or Slatt and like works, of what depth soever the same be within the earth which usually annoy the same; [the riseing water being constantly counterpoyzed and raysed by the meanes of two or more fixed pipes conjoined unto and concentring in the long pipe wherein the water is raysed, and alsoe by the meanes of Certeyne valves or doores, artificially and rightly placed;] and which without a very greate expense in Servants wages horses or the like cannot be gayned or wrought upon by reason of the waters springing in or falling into the same; of which said new way and invencon soe brought to perfecon by the long studdy and much charge of the said Edward Ford as aforesaid, hee the said Edward Ford is the true owner and first inventor: And forasmuch as the said new way and invention is and may be of greate use to the publique in divers parts of the three nacons of England, Scotland, and Ireland, and the domeynions thereto belonging, and was never till now brought to perfect use and practice."

The document proceeds to confer protection of the invention for fourteen years, "and forasmuch as many parts in and about London and Westminster are in great want of water and thereby in the more danger of fire and other mischieff," it confers the right of erecting and laying engines, cisterns, pipes and other apparatus for the supply of water to the cities of London and Westminster and any adjacent parts. A clause is inserted to safeguard the rights of John Rushworth and of William Potter, for whose inventions patents had been granted lately.[6] This clause will perhaps explain or remove a difficulty which is met in reading the part of the patent that has been quoted above. The sentence, which for convenience of reference has been placed in brackets, does not read in with the context. It seems to be an interpolation and possibly it was determined upon after the document was drawn up and was inserted by the draughtsman at the most convenient vacant space that he could find, and it is suggested that it embodies a brief description of Ford's invention and was inserted at the instance of Rushworth and Potter, or one of them, to strengthen the clause securing their rights. Unfortunately, if this is the case, it will be seen that Ford had devised an impracticable scheme, and at any rate the description "the riseing water being constantly counterpoyzed and raysed by the meanes of two or more fixed pipes conjoined into and centering in the long pipe wherein the water is raised, and alsoe by the meanes of certeyne valves or doores artificially and rightly placed" cannot in any way be applied to the pump actually set to work, a description and sketch of which we owe to a French traveller, Monsieur Balthasar de Monconys, who visited London in 1663.[7] The sketch, which is reproduced herewith, is fairly clear. The lift of 120ft. was performed by a series of four suction pumps worked by levers from a vertical rod made in sections jointed together. The lower end of the vertical rod rested on a face-wheel with twelve cams, which wheel was mounted on a vertical shaft turned by horses. At the lower end of the rod was a bronze friction roller, and the cams were of wood faced with iron. The pivots of the levers are not shown, but it is pretty clear that the suction stroke of the pumps was performed by the weight of the rod. Monconys says that sixteen livres—say, 17 lb.—of water was raised at each stroke.

In "The Art of Water Drawing," by R. D'Acres, 1660, we have another description by a native writer a few years earlier in date, for there need be no hesitation in considering that "the new works in the Strand" referred to by him is no other than Ford's. This account suggests that the installation was not got to work without difficulty, and that the arrangement sketched by Monconys was not the original plan. Although written by a man who had studied pump work, it will be seen that D'Acres's description is not at all clear. He says (p. 17):—

> "The contrivance in that new works in the Strand making steps and notches in a fixed bench, and surrounding the horse gin, sloped for the more facile pulling up of the weights, after their suddain and perpendicular falling down, which weights so falling down, ballance up the water in the force work, as may there further be seen, none of which suit well either with men or cattell, by reason of their starts, jerks, and girds, which living movers will not nor cannot so well endure. The removal of this inconvenience hath been attempted, with voluble moving wheels, but not to full satisfaction."

This account seems to indicate that force pumps and a stationary cam ring had been tried before the suction pumps and rotating cam wheel described by Monconys.

Anthony Wood's account of Ford's waterworks is of little value, but it seems to put the lift at 93ft., not 120ft., as Monconys has it. The works were, according to this author, "done at his own charge, and in one year's time, with his rare engine he had invented for that purpose, by which several parts of the nation did afterwards find benefit in the draining of mines and lands, much better and cheaper than any other device before."[8]

At about the same time as Monconys another visitor from France, M. Sorbière, inspected the works. His account is a short one, but it suggests that there was a forcing pump in addition to the suction pumps; he says, "à la pompe aspirante on a adjousté quelque impulsion."[9] However, Sorbière was not so interested in, nor so well qualified to discuss, mechanical devices as was Monconys. The works are mentioned again in the "Travels of Cosmo the Third, Grand Duke of Tuscany." Magalotti, the author, says that "His Highness went to see an hydraulic machine upon a wooden tower in the neighbourhood of Somerset House."[10] The entry is put under the date May 23rd, 1669, but, as will be seen later, the works were no longer in existence at that date. Possibly it was the Durham Yard works[11] that the Duke inspected, and Magalotti in writing up his notes confused it with the Somerset House works, of which he found an account in Sorbière's book.

The appearance of the wooden tower erected by Ford as well as its site can be gathered from a plan of the district by Hollar. The works stood about 30 yards to the east of the public landing stage known as Strand Bridge, which was approached from the Strand by way of Strand-lane, between the grounds of Somerset House and those of Arundel House. It was in the line of the present Surrey-street and possibly stood where that line cuts the Temple railway station. As Monconys says, from the top of it a fine view could be had of the surrounding district, including the Temple and the Palace, that is to say, of Somerset or Denmark House. Now, at the Restoration this house had become the residence of Queen Henrietta Maria, the mother of Charles II., and very soon she began to find it an annoyance to have the house and grounds under the observation of people from the top of the tower. Accordingly we find the King writing (July 31st, 1664) to Ford and his partners, James Hayes and Thomas Togood, that "The great fabric of wood which they have erected for raising water from the Thames, on the soil of the river, is a nuisance, especially to Denmark House, and must be removed within three months; but considering the cost they have been at in its erection, he gives them the choice

* Newcomen Society, January 23rd.

of removing it so as to preserve the materials, otherwise it will be removed, and they punished for the delay."[12]

There is no reason to think that the order was not obeyed, but the carrying of it into effect meant that a number of houses would be deprived of their customary supplies of water. We read that "hundreds of people have laid pipes and taken leases for a supply of water," so in response to a petition from Ford and his partners the King directed the Attorney-General to draw up a licence for the erection of a works between Temple Bar and Charing Cross, with the proviso that the tower was not to be more than 15ft. high.

A tower 15ft. high, near the river, would be of very little use as a means for securing a head of water, and what followed is not at all clear, for although some sort of pumping plant was set up at Durham Yard, where the Adelphi now stands,[13] there is no evidence that Ford was interested in it or that he concerned himself further with waterworks; indeed it seems likely that once the Somerset House plant had been erected and set to work he had left the conduct of the business to his partners.

He had before this, as we are told by Pepys, become concerned in an invention for curing smoking chimneys. "This day my wife showed me bills printed wherein her father, with Sir John Collidon and Sir Edward Ford, have got a patent for curing of smoking chimneys. I wish they may do good thereof, but fear it will prove but a poor project."[14] Most likely Ford merely lent his name to this project and took no very active interest in it; certainly he was not one of the patentees.[15]

In 1666 Ford put forward certain financial schemes in a little book with the title "Experimental purposals, how the King may have money to pay and maintain his fleet with ease to his people; London may be rebuilt and the proprietors satisfied," &c.

His main interest, however, was in an invention for coining. "He invented a new way of farthings, of which he made demonstration to the King and Council so plainly that they were satisfied that they could not possibly be counterfeited, and that one farthing could not be like another, but that they should differ in some little thing.[16] Ford sought a monopoly of making farthings and offered the King to pay him 6s. 8d. for every pound's worth of farthings vented, but there were at this time several other projectors, including Prince Rupert, who asked for the same privilege, so in the end Ford had to be content with a monopoly for Ireland. To Ireland he went in 1670, and there he died soon after, too soon to have seen his scheme carried out. His body was brought home and buried at Harting on October 15th, 1670.

As we have seen, the Somerset House waterworks was at work for eight or nine years at the most. The other pumping installation in which Ford was concerned, that at Wapping, had a longer life, but whether it had the same machinery is not known; nor is it known definitely that similar machinery was employed elsewhere. Anthony Wood, indeed, speaking of Ford's "rare engine," says that by it "severall parts of the nation did afterwards find benefit in the draining of mines and lands much better and cheaper than any other device before," and, in spite of there being no evidence to confirm this statement, it is quite possible that Ford's plan for working a set of pumps by horse gear may have been applied in mines, for it seems pretty clear that many means for raising water from mines were being tried at this period, of which no records have come down to us.

[1] Newcomen Society, Wednesday, January 23rd.

[2] The name Broken Wharf will be found in the current "London Directory" under "Upper Thames-street."

[3] Clarendon, "History of the Rebellion," &c.

[4] Cromwell was made Lord Protector in December, 1653.

[5] Patent Roll No. 2913/46. A list of inventions protected during the Commonwealth and Protectorate, prepared by the present writer, will be found in "Notes and Queries," 2, VII., 162 (March 1st, 1913).

[6] Another patentee of water-raising apparatus was a man named Hele. In 1657 there was a dispute between him and Ford about their respective patents.

[7] "Journal des Voyages de Monsieur de Monconys," 1666, Vol. II., p. 29.

[8] Wood, Anthony, "Athenæ Oxonienses," ed. Bliss, 1817, Vol. iii., p. 906.

[9] Sorbière, "Relation d'un voyage en Angleterre, &c.," 1664.

[10] Magalotti, "Travels of Cosmo the Third, Grand Duke of Tuscany."

[11] The Durham Yard works stood where the Adelphi now stands. It was in existence in 1667.

[12] Calendar of State Papers, Domestic, Charles II., 1663–4, p. 655, July 31st. It appears that Ford and his partners had other works at St. Giles in the Fields, and at Wapping.

[13] With this works is associated, in 1667, the name of Sir Robert Vijner; it supplied St. Clement Danes and other parishes.

[14] Wheatley's "Pepys," Sept. 22nd, 1663.

[15] The patentees were "John Colladon, doctor in physick, and Alexander Merchant of St. Michael," No. 138, A.D. 1662.

[16] Wood, "Athenæ Oxonienses, ed. Bliss, 1817, Vol. iii., p. 906.

Power from Warm Water.

SOME two years ago, it will be remembered, Monsieur Georges Claude and Professor Paul Boucherot propounded to the French Académie des Sciences a scheme for developing power by taking advantage of the difference in temperature between the surface and the depths of the tropical seas. The idea consisted in causing the warm water to boil, or at any rate to give off vapour very rapidly, by reducing the pressure above it. This vapour was to drive a turbine and then to be condensed by cold water drawn from the bottom of the sea. We discussed the project at length in our issue of November 26th, 1926, admitting, of course, its theoretical possibility, but giving calculations to indicate the enormous magnitude and cost of the machinery required to develop even a very small power, apart from the practical difficulties of working with vapour under a very high vacuum the whole of the time. In spite of these obvious objections, a step has been taken towards the realisation of the project, not, we may say, on the scale of the 400,000 kW plant envisaged by its authors, but in the shape of a 50 kW unit which has been tested at the works of the Ougrée-Marihaye Steel Company in Belgium. The turbine and dynamo were built by the Société Alsacienne de Constructions Mécaniques at their Belfort works, and in the latest *Bulletin* of the company are given some interesting particulars of the machine and its performance.

The turbine is a single-stage machine and has the outward appearance of a very short double-flow low-pressure cylinder of an ordinary reaction turbine. Steam enters through one of the ends, flows axially through nozzles in a diaphragm bolted between the ends, passes through the single row of blading, and to the condenser through the exhaust end. The inlet end casting serves as a support for the dynamo and the governing gear of the turbine. The bladed wheel has a mean diameter of 800 mm., or about 31·5in., and runs at 6000 revolutions per minute, driving directly a dynamo generating continuous current at 220 volts. The sizes of inlet and exhaust branches are not stated, but from the drawing one would gather that the diameter of the former was about 27·2in. and the latter 40·9in. The effective length of the blading appears to be about 8in. The blades have a very decided twist. They are said to work as pure impulse blades near the roots and with 25 per cent. of reaction at their shrouding. They are composed of chrome rustless steel, heat treated. A point of interest in the design is the complete enclosure of the outboard turbine bearing in a vacuum-tight casing so as to avoid the necessity of a gland at that end of the shaft. This bearing has its own forced lubrication system, also, of course, working under vacuum, a gear pump in the casing being driven from the shaft end by worm gear. The turbine is governed by the admission of air on the exhaust side, a system patented by Messrs. Claude and Boucherot and designed to avoid the very large throttle valves which would otherwise be necessary. Another method of governing is by regulating the quantity of warm water admitted to the evaporator.

The following table gives both the designed conditions and the test results of the plant.

Designed Conditions and Test Results of 50-kW Vapour Turbine.

	Designed conditions.		Test conditions.	
Output	50 kW	50 kW	54·9 kW	54·9 kW
Speed in revolutions per minute	6000	6000	5500	5500
Temperature of inlet vapour	25 deg. Cent.	77 deg. Fah.	35·8 deg. Cent.	96·4 deg. Fah.
Absolute pressure of inlet vapour	0·0323 kg./sq. cm.	0·459 lb./sq. in.	0·06 kg./sq. cm.	0·853 lb./sq. in.
Dryness fraction of inlet vapour	96 per cent.	96 per cent.	94·7 per cent.	94·7 per cent.
Temperature of exhaust vapour	11·5 deg. Cent.	52·7 deg. Fah.	28 deg. Cent.	82·4 deg. Fah.
Absolute pressure of exhaust vapour	0·0125 kg./sq. cm.	0·178 lb./sq. in.	0·0387 kg./sq. cm.	0·55 lb./sq. in.
Adiabatic heat drop	23 calories	41·5 B.Th.U.	13·9 calories	25 B.Th.U.
Specific volume after expansion	91 cu. m./kg.	1460 cu. ft./lb.	33·5 cu. m./kg.	1183 cu. ft./lb.
Total vapour consumption per hour	3170 kg.	6990 lb.	6110 kg.	13,472 lb.
Ratio of steam to blade speed	1·75	1·75	1·46	1·46
Hydraulic efficiency	74·5 per cent.	74·5 per cent.	68·2 per cent.	68·2 per cent.

The calculated hydraulic efficiency for the conditions of the test was 67·1 per cent., but on test a figure of 68·2 per cent. is said to have been realised. This efficiency implies a velocity coefficient of 0·955 for the guide blades and of 0·90 for the running blades. Taking the figures given in the table, it would appear that under the conditions of the test the efficiency ratio of the unit was about 55·6 per cent. The dryness fraction of the steam was obtained by chemical means. A known small quantity of a mineral salt was dissolved in the water in the evaporator. The quantity found in the condensate was determined, the assumption being made that the only way for the salt to have got there was in droplets of liquid carried over in the vapour. A "Willans line" given in the *Bulletin* referred to shows the total vapour consumption of the plant per hour to vary from 3500 kilos. at 5 kW output to 6500 kilos. at 60 kW output, though it is not clear for what vapour conditions the line has been drawn. The test results tabulated above were obtained during the month of June last, when the temperature of the river Meuse was about 66 deg. Fah., a circumstance which accounts for the conditions being further from those specified than otherwise would have been the case.

No information is given as to the source of the heat which produced the working vapour at a temperature of 96·4 deg. Fah., but if the heat of the water itself was used to effect the evaporation, as in the original Claude-Boucherot proposals, the quantity of water required to supply the latent heat of 13,500 lb. of vapour per hour without a too great fall in temperature must have been something very considerable indeed. And all this for 55 kW, from which has to be deducted the power to drive the pumps and to maintain a 29in. vacuum. One can appreciate equally the enthusiasm of the inventors, the enterprise of the Ougrée-Marihaye Company, and the skill of the Société Alsacienne in the production of the plant referred to, without being convinced that the system can ever justify its application commercially.

Notes on the Fitting and Operation of Michell Bearings.

A PAPER on Michell bearings given by J. F. Petree, A.M.I. Mech. E., A.M.I.N.A., before the Junior Institution of Engineers on January 18th, drew attention to the fact that the original British patent was granted to Mr. A. G. M. Michell for his bearing nearly twenty-five years ago, and that it now found application in machines of diverse types in some of which the special needs essential to the satisfactory working of the bearing were not understood; some of them being in thrust assemblies without proper provision for oil circulation and with insufficient oil capacity. It was pointed out that the oil in a Michell bearing had to do duty as a coolant as well as a lubricant, and it was the former function which determined the amount of oil for which the housing and the circulating and cooling arrangements must be proportioned. It was important that as thin an oil as possible should be used in order to reduce the losses that must occur if a thick oil was thinned down by heat generated in the bearing itself.

The positioning of the pivotal point or line on the backs of the pads was referred to, and the effect of its position behind, before or on the centre line of pressure on the pad explained, the last position being usually used in situations involving a change in the direction of rotation without alteration in the direction of the thrust, *i.e.*, in the adjusting blocks of reversible turbines. The advantages of a line pivoted pad compared with a point pivot was its ability to stand up to pressures which would crush a point pivot, and, further, as the working face of the pad was parallel to both *its* back surfaces—the "line" being a definite step between the latter two planes—an accurate measurement of the pad thickness could at any time be made. Pads being machined in sets, they should be replaced in sets when renewal was necessary.

Pads were made either of cast iron, cast steel, gunmetal or phosphor bronze, the choice depending mainly on load and cost, resistance to bending being the first consideration. It was found in practice to be advisable to coat the front of the pad with white metal, at all events for loads up to several thousand pounds per square inch, and it was essential if the bearing was to start under load; as although the oil film was struck at a rubbing speed of less than 10ft. per minute, a bearing which had been standing under load for some time and was then required to start under load, might suffer damage in the short interval before the film was struck. The white metal absorbed sufficient oil to provide a greasy film for starting, even after long periods of inaction. In remetalling, a mixture of copper 5·5, tin 86·0, antimony 8·5 per cent. would be found a safe selection. The white metal should be held by dovetailing into the pad.

In contrast with the ball bearing the load-carrying capacity of the Michell bearing increased with the revolutions and was a feature not always appreciated.

It was stated that probably more than 90 per cent. of such troubles as were met with in the running of Michell bearings could be attributed to an insufficiency of oil or to dirty oil. Lubricants could be applied in three ways, plain bath lubrication, where the oil level was at the underside of the shaft; flooded lubrication, where the whole housing was filled with oil and involving the use of shaft glands, which should not compress the packing hard on the shaft; and force feeds, usually found in geared turbine installations. The author said that there was no truth in the assertion sometimes made that a forced lubrication pump was a necessary adjunct to a Michell bearing.

South African Engineering Notes.

Large Truck Order.

THE Railway Administration recently stated that, with a view to making provision for increased truckage to meet traffic requirements during the next financial year, the Administration has decided to proceed with the ordering of six hundred 40-ton bogie tractors, 150 bogie cattle trucks, and 300 four-wheeled cattle trucks, at an estimated cost of over £500,000. Tenders will soon be called for. Great Britain has obtained a good proportion of the orders of the Union Government for railway requirements recently, especially as regards trucks, but Belgium has also been successful, and is sure to make a big effort to get the order.

Lobito Bay Harbour.

Lobito Bay is likely to make rapid progress within the next few years, as when the Benguela Railway is completed, linking up Lobito Bay, in Portuguese West Africa, with Elizabethville in the Belgian Congo, Lobito Bay should then come into its own as a valuable West Coast port. For the last two years the Portuguese Government has been constructing a wharf, which is now rapidly nearing completion. For six months past, in fact, it has been possible to accommodate ocean-going vessels alongside the completed portion of the wharf. The Portuguese section of the railway from the Port to the Angola-Belgian Congo frontier has just been completed, and the Belgian Government is bringing up material and pushing ahead with its uncompleted section. Parties of Belgian engineers and workmen have for several weeks been arriving by the mail boats from overseas, and proceeding by rail to the Belgian Congo to assist in the railway construction, and considerable consignments of railway material, of which 40,000 tons in all will have to be imported, arrived during October and November. The work is expected to be completed in 1931. The new railway will divert large quantities of goods which at present are carried either to Beira or to South African ports. Most of the copper and other metals produced in Northern Rhodesia and the Belgian Congo will certainly be shipped through Lobito Bay, and mining machinery, material, and so on will be imported through that port.

Newcastle Blast-furnace Blown In.

The Newcastle blast-furnace of the Union Steel Corporation was lit up again on October 15th after many months of idleness, during which period the furnace was entirely reconditioned and the works extended by the provision of additional plant. It is the present policy of the Corporation to work its furnace at full capacity, which is between 50,000 and 60,000 tons per annum, so that there

should be no question as to the payment of the bounty on future production. The statement recently made by the members of the Board appointed by Government to initiate the State-controlled iron and steel industry, to the effect that it has in preparation a comprehensive scheme for co-operation between the State iron industry and the Union Steel Corporation is of great importance, as indicating a recognition of the rights of private enterprise to sympathetic consideration at the hands of the State industry. It seems quite possible that a workable arrangement should be arrived at. The Union Steel Corporation in 1927 had an output at its Vereeniging works of nearly 30,000 tons of steel, and with the subsidiary industries about to come into operation, as, for instance, Stewart and Lloyds' tube and pipe-making works, it should be possible before the end of next year to absorb the whole of the production of the blast-furnace. By obtaining control of what may be considered the largest known coking coal area in Natal, that of the Vryheid Coronation Colliery, Ltd., a subsidiary company of the Coronation Collieries, Ltd., the Union Steel Corporation has definitely secured ample future supplies of coke.

Union Steel Corporation (S.A.).

According to the annual report of the Government Mining Engineer, the Vereeniging works of the Union Steel Corporation (of South Africa), Ltd., produced during 1927 27,188 tons of manufactured steel, of a total value of £359,087. The nature of the product did not materially vary from that recorded in previous years. Iron castings totalling 626 tons, valued at £17,006, were also made, and shoes and dies amounting to 447 tons, of a value of £8938. The productions of the foundry department consisted, as in previous years, of iron and steel castings of various descriptions, supplied to the order of the South African Railway Administration, the mining groups, and public undertakings. The average labour employed during the year included 276 white and 495 coloured persons. An open-hearth Siemens-Martin basic furnace of 35 tons capacity was placed in commission, and a new 12in. odd section mill was installed, with the necessary reheating furnace plant.

Vianini Reinforced Concrete Pipes.

The presence of huge sand deposits of excellent quality has been the means of attracting an important industry to the town of Brits, Transvaal, namely, the manufacture of reinforced concrete pipes under the Vianini patented processes. The Crocodile River has in past centuries brought down vast quantities of detritus from the Pretoria beds, and on arrival in the flat country this silt has been deposited in great banks, originally in or adjacent to the normal river bed, but now, in places, left high and dry as the course has changed. The sand thus left is remarkably well graded, sharp and clean, so clean that it can be used with cement without any preliminary washing. The Vianini reinforced concrete pipe is formed by the centrifugal moulding process, and one of the chief features of the pipe is that each length includes at one end a belled socket which will take the parallel end of the next length, allowing annular space for jointing, and this socket is an integral portion of the pipe, formed in the one operation of spinning. The Vereeniging wire works is the sole source of supply of all the wire and rod that the works requires. The smallest size made by this process has an internal diameter of 4in. Two machines are installed for turning out pipes from 4in. to 10in. in diameter, with an effective length of 6ft. One larger machine handles pipes from 12in. to 30in. in diameter in 12ft. lengths, while the largest machine turns out 8ft. lengths in diameters from 36in. up to 72in., with a maximum length of 2 m. The plant, which has lately been completed, is driven by a two-cylinder cold-starting horizontal Diesel engine, of Ruston-Hornsby design, rated at 100 B.H.P., supplied through the local agents, Herbert Davies and Co., Ltd.

Central African Railways.

The opening of the Bukama–Port Franequi line, which is a continuation of the Chemin de Fer du Katanga, by the King of the Belgians recently is a further important event in railway progress in Central Africa. Railway development in this vast territory, nearly eight times the area of Great Britain, has been somewhat disconnected owing to the natural provision of many thousands of miles of navigable waterways. During the last five years, however, there has been a very definite attempt to consolidate the railway map of the Congo, and in addition to new construction, a big mileage of narrow-gauge lines is to be converted to the 3ft. 6in. gauge standard. Some idea of the progress taking place is given by the fact that in 1926 there were roughly 1500 miles of railway in operation, whereas it is estimated that in 1931 the mileage will reach 4000, most of which will be of the 3ft. 6in. gauge. The length of the new Bas-Congo line is 696 miles and its completion establishes a continuous 3ft. 6in. gauge from Port Francqui—latitude 5 deg. South—to Cape Town —latitude 34 deg. South—a distance of nearly 3300 miles. This new trans-Congo line will ultimately be continued to Leopoldville—400 miles—but for the present river transport will have to be used. The Chemin de Fer du Congo is now being reconstructed throughout, and the existing gauge of 2ft. 6in. altered to the standard 3ft. 6in. gauge, thus ensuring in due course the same gauge through to Cape Town. The approximate distance from Matadi to Cape Town is 3922 miles. The line between Matadi and Leopoldville will be completed in about three years' time. This railway has 151 locomotives, 32 of which are of the "Garratt" articulated type, and were built by the Société Anonyme de St. Leonard, of Liege, Belgium, under arrangement with Beyer, Peacock and Co., Ltd. They have an 0–6–0, 0–6–0 wheel arrangement, and a tractive effort of 22,500 lb.—75 per cent. boiler pressure—their total weight being 38 tons.

New Station for Johannesburg.

One of the biggest contracts in the history of Johannesburg is now on offer, for the South African Railway Administration has just announced that tenders are now wanted for the construction of a new railway station for Johannesburg. The estimate for the new station, including extensive excavations which are now nearly completed, is about £1,000,000. Much of the money will, of course, go in such building materials as granite, brick and cement, and wages will be a very big item, but many thousands of pounds worth of ironwork, mainly in the form of girders, will also be required. Jeppe, near Johannesburg, is also to have a new station, and for the purpose or relieving traffic congestion now existing in Commissioner-street and Marshall-street at the railway crossings in Jeppe, the railway authorities are going to erect two bridges.

Table Bay Docks.

The Railway and Harbour Administration of the Union of South Africa has completed a system of flood lighting in the dock area, comprising over forty projectors, each carrying a 1000 watt lamp. Groups of these lamps are mounted on steel towers, two of which are 75ft. high and six 45ft., while others are mounted on lofty structures, such as the elevator. Local lighting has also been greatly improved, and it is now possible to carry on loading and unloading by night practically as efficiently as by day. Some visiting merchant captains and shippers have expressed the opinion that the lighting of the harbour area is now second to none in the world.

New Cement Works.

A new cement works has just been erected near Port Elizabeth, and was expected to be ready to begin operations before the end of November. The kiln, 145ft. long, 8ft. diameter, and weighing over 350 tons, has been lit up, and everything appears to be perfectly satisfactory judging from the appearance of the first batch of clinker produced. Progress with this works has been rapid, as it was only commenced eleven months ago.

Road Transport Vehicles.

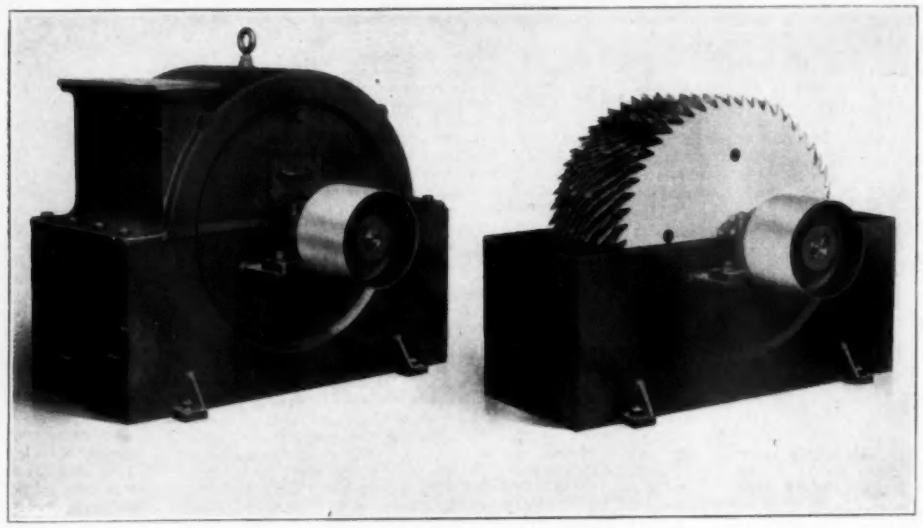
About 700 super-Sentinel steam wagons and tractors are now in operation throughout South Africa and Rhodesia. They work at remarkably low costs per ton-mile on loads varying from 6 to 20 tons per trip, and their all-in costs, including repairs and maintenance, depreciation, wages, fuel, tires, &c., vary from 3d. to 6d. per ton-mile, depending on the working conditions, roads, &c.

The tractor is recommended in preference to the wagon for country road transport over bad roads, and for short run work. It has the great advantage over the wagon of lower axle weights, and enables the load to be split when passing over bad sections of country, sluits, gradients, &c. For short run work, with the necessary quantity of trailers, it is possible to haul with the tractor almost continuously, instead of having to wait for the vehicles carrying the load to be loaded and off-loaded, and in many cases, as a consequence of this, three times as much tonnage can be transported in a given time with the tractor as compared with the wagon which has to wait for the loading and unloading operations. Steam road vehicles, however, are not so advantageous if employed for intermittent work, because unless the boiler be fired more or less continuously, delays occur in raising the steam pressure.

For loads of 4 and 6 tons per trip, the cost of fuel for the Diesel lorry, under the conditions which prevail in South Africa, only amounts to one-third to one-fourth that of petrol in a corresponding petrol lorry. The Diesel oil lorry should, therefore, find a very large market in this country for loads of 4 to 6 tons per trip in the very near future. Two M.A.N. 6-ton lorries of this type have already been sold for the Bloemfontein and Johannesburg districts, and if the results obtained with them are anything like as good as are now being obtained in Europe with similar vehicles, there should be a rapid demand for these Diesel oil lorries. For loads below 4 tons per trip, and for intermittent work, and in cases in which very rapid transport is required, the modern petrol lorry is the most suitable vehicle at the present time, especially as the capital cost of such vehicles is now comparatively low. These vehicles now operate on giant pneumatic tires, and their maintenance costs, even at high speeds over comparatively bad roads, are within commercial requirements. Their actual operating cost, however, per ton-mile, is said to be twice or three times that of steam vehicles, when heavy continuous transport is available.

MULTIPLE-DISC DISINTEGRATOR

THOMAS ROBINSON AND SON, LTD., ROCHDALE, ENGINEERS



A Novel Disintegrator.

A NEW type of puiveriser or disintegrator that has, so we understand, proved remarkably efficient for the treatment of mill screenings, bran and all kinds of grain, as well as such materials as maize cobs, malt combings, nut shells, bones and spices, is now being placed on the market by Thomas Robinson and Son, Ltd., of Rochdale. It is called the Smith-Hayes pulveriser, and is the invention of an Australian, Mr. O. Smith, as the result of long experience in the flour milling industry. The machine is of simple design and robust construction, as will be observed from the two illustrations, which show the complete appliance with and without its cover. The machine consists of a cast iron casing in two halves and a revolving shaft, which revolves in ball bearings, and on which is secured a number of gulletted discs. The top half of the casing is serrated inside, as is also one half of the lower portion on which the stock is ground. The other half of the lower section consists of a screen through which the ground material passes, and this screen can be readily changed and replaced when desired. The speed at which the shaft revolves is 1800 revolutions per minute. The material to be ground enters in the direction of rotation of the discs, and is opposed by a serrated iron plate, the serrations of which incline towards the direction of rotation of the discs, thus tending to hold the stock against the gullets of the discs. When the material leaves the serrated plate approximately 90 per cent. of it is fine enough to pass through the screen, while the remainder is carried by centrifugal force to a set of finer serrations on the top cover, and is there reduced to a degree of fineness sufficient to enable it to pass through the screen in its second passage.

The shape of the gullets in the discs and plates has been arrived at after long and careful tests on tough and abrasive materials, so as to offer the maximum resistance to wear and retain the cutting properties. The screen and its fixings are readily exposed by releasing a set of wing nuts and removing a steel end plate. The screen frame is held in position by a tapered strip located by three set screws, the slackening of which allows the frame to be removed when desired.

There are several methods by which the material can be fed into the machine. First, a direct feed by means of a spout, a method which is only recommended when the material is known to be free from foreign matter; secondly, a feed over horseshoe or electro magnets, when the material contains particles of iron or steel, but is free from non-magnetic metals and stones; thirdly, feed from an air belt aspirator, which is an ideal arrangement for the treatment of materials containing magnetic and non-magnetic metals, the aspirator being suspended from joists or placed on the floor directly above the grinder. A further method of feeding is one in which a small fan and cyclone dust collector is used. In this case the aspirator is attached to the feed inlet of the grinder, and a current of air is drawn through the machine, taking with it all the material passing through the screen and depositing it in the cyclone, from the bottom of which it is run into sacks.

IN the course of a study of the formation of peat being conducted by the American Bureau of Mines, samples of peat have been collected at various depths in Wisconsin peat bogs, and are being analysed to determine the rate of decay of various vegetable constituents, such as woody matter and cellulose. The main question to be decided is whether wood (lignin) or cellulose, the principal constituents of plants, decays completely in the process of peat formation. If either decays completely, leaving no solid decomposition products, it can be concluded that the other is the original substance from which coal was formed. It is generally conceded that coal was formed from peat. Since the action of bacteria plays an important part in the decay of vegetable matter, a thorough investigation of this phase is now being made. It has been found that bacteria exist at all depths in the peat bogs, but they are probably more or less dormant in the lower levels. It has been found further that where bacteria have become dormant their activity is quickly resumed when supplied with available nitrogen.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Market Conditions.

THE improvement in demand for iron and steel noted last week has been maintained, but it has affected makers to a varied extent. While some producers are doing decidedly better business, others have but slightly increased orders on their books. Nevertheless, the mass turnover is larger, and Midland and Staffordshire producers are more cheerful. Yet, while they are hopeful, they move cautiously, bearing in mind that the present buying movement may only mean the replenishing of stocks following the end of the year settlement. They sincerely hope it is the advent of a general revival of demand, and that it will be maintained, but they do not feel disposed to "bank" on it. Manufacturers in this area persist in cautiously placing orders, and buying is restricted to supplies sufficient to cover current and immediate future needs. A continuance of the improved position at the works would give them confidence, and it is needed to induce the placing of forward contracts such as used to be given out.

Raw Iron.

The progress towards normal conditions in the pig iron branch of industry has been maintained this week. Smelters both in Derbyshire and Northamptonshire, state that specifications are coming in more briskly against contracts, but there continues to be considerable hesitation on the part of consumers to place new forward orders. In some important branches of the trade, order books are much more bulky than they were three months ago. Early delivery is stipulated with most of the business now being placed, but blast-furnacemen are caused no concern by this clause. There are still considerable stocks at the furnaces, but they are gradually being reduced. Present output in this area is considered to be about equal to the consumptive demand. Production has been reduced in Derbyshire, as one furnace was blown out some weeks ago. Derbyshire smelters are selling No. 3 foundry at £3 per ton. They are hardly satisfied with that price, however, and are using every endeavour to get it up to £3 1s. Most houses this week quote the higher figure when first approached. Northamptonshire foundry material sells at £2 15s. to £2 15s. 6d. That district has not benefited like Derbyshire from recent displacements of supply, and bargaining has not quite so confident a tone. Demand for forge sorts continues small, and output has been curtailed till at date it reaches very meagre proportions. Indeed, it is asserted that, were an active demand suddenly to show itself, considerable stringency would soon become apparent. Quotations are unchanged at £2 11s. 6d. to £2 12s. 6d. for Northamptonshire and £2 16s. to £2 17s. for Derbyshire. In this department of the raw iron market the buyer has the whip hand.

Steel.

Despite the recent improvement in demand for heavy steel, supplies exceed consumers' requirements. There is ample room for betterment in sales of structural steel, orders for which continue to be of very small size. Steel mills are feeling the increased use of plates and sections following the better employment at the shipyards on the North-East Coast and the Clyde. English billets at £6 5s. are difficult to dispose of, but there is a steady sale of steel bars to the motor trade. Re-rollers are quoting £7 15s., and it would probably be possible to buy bars rolled throughout with English material about the same price. Continental values have again risen, and it would be difficult to get billets under £3. Staffordshire producers welcome the advance which narrows the gap between the foreign and British product. Belgian No. 3 iron now stands at £7 5s. delivered, the highest price for some months. Imports of continental semi-finished steel have been diminishing during the last few months, and there is less incentive to buy this week. It is believed that the Belgian railways have been placing good orders with the local mills, and that accounts to some extent for the advance in prices, although it is well known that the continental works have been well booked from their own market for some time. Demand for English billets is still slow, and Welsh makers are said to have shaded the £6 5s. figure to induce the placing of big business with them; for small tonnages, however, they would want the price generally quoted by Welsh and English makers.

Finished Iron.

Conditions in the wrought iron trade show no variation from those existing a week ago. Orders, mostly of small contents, continue to come in, especially to the marked bar houses, and mills are running regularly. Makers sustain prices at £12 per ton. They can cope with much more work and would be pleased to see orders of greater bulk coming along. Crown bars and common bars are selling only irregularly, and values are about upheld. The chain and cable section of the Staffordshire iron trade shows improvement, which is due, probably, to the livelier condition of the shipbuilding and ship-repairing industries. In Crown iron there is a good deal of competition for the export business, which explains the wide variety of quotations; while in nut and bolt iron the heavy importation of cheap Belgian bars and the change-over to steel as the basis, are alike responsible for the small business now being done. Local ironmasters take some encouragement from the rising tendency of Belgian iron prices. Crown bars are quoted £9 2s. 6d. to £10, and nut and bolt and fencing iron £8 10s. to £8 17s. 6d. Demand for wrought iron gas tube strip keeps up well and sales are effected at recent rates.

Galvanised Sheet Prices.

In the galvanised sheet trade there is no lack of activity, and following upon the advance of half-a-crown asked a week ago by some makers, higher prices have become the rule. The basis for galvanised corrugated sheets of 24 gauge has been raised to £13 12s. 6d. Black sheets can be bought at the prices previously ruling. The increase in price does not appear to have affected the placing of orders and on 'Change in Birmingham to-day—Thursday—a steady business was done. The sheet department is one of the most fortunate and the mills in some cases have work to keep them busy for as much as three months ahead. An attempt by tin-plate manufacturers to improve upon current rates is foreshadowed, but market conditions here afford little encouragement.

Scrap.

There is a better market for steel scrap, and Birmingham merchants have, in a number of cases, been able to command an advance of half-a-crown on recent values. Heavy steel scrap is quoted this week £3 10s., delivered South Wales, but it is believed supplies are still available at £3 7s. 6d.

Professor's View of Trade Situation.

Professor J. F. Rees, of the Faculty of Commerce, Birmingham University, in the course of an address in Birmingham on the 16th, gave vent to the opinion that this year was not likely to be a considerable improvement on the last, and the reason he thought so was because of the condition of certain basic industries. Having spoken of the conditions in the cotton and coal industries, he said that the iron and steel trade, so greatly stimulated by the war, suffered from excess capacity of production, and it seemed pretty clear that the industry would need a considerable amount of what was called rationalisation. The Germans had followed that course, but in this country the attitude was individualistic; still, the question would have to be faced whether the old conception of competition could be held by in present circumstances, and whether modification was not necessary. There were a few hopeful signs. So far as it went, it was hopeful that 1928 was a year of very little industrial strife, compared with the years immediately preceding; and, of course, they had the Melchett-Turner Conference about establishing better relations between employers and employed. That was altogether good as far as it went. Another hopeful sign was the growing attitude of understanding, or more friendly approach to ideas of reorganisation. Whether by reorganisation or rationalisation, something was likely to be done in this direction in the next year or two.

An Optimistic View.

The comments of Mr. F. G. Goodenough, chairman of Barclays Bank, on the industrial situation and his optimistic outlook have received the careful attention of industrialists hereabouts. The authority of his position and his well-reasoned observations help to strengthen the favourable opinion as to the future of local manufacturers. They are in agreement with him that, lately, the iron and steel industries and certain allied trades have shown some improvement, and they note the foundations on which he bases his opinion that there is "ample ground for a confident and hopeful feeling." He attributes the improved outlook in part to the great efforts being made to place the depressed industries on a more satisfactory footing, both as regards economy and efficiency; in part, also, to what is being done to develop new outlets for trade and to improve the marketing of goods on more scientific lines. It is remarked upon that the tendency to amalgamations gains his approval.

Machinery Exports.

Midland engineers have this week been commenting upon the marked improvement last year in exports of machinery. The advance of nearly four millions on the total for 1927 is considered highly satisfactory. It is noted, however, that electrical machinery did not quite hold its own. The best markets were found in Greater Britain. India was a good buyer of electrical machinery, prime movers, and other descriptions of industrial plant. Russia figured among the European buyers of British machinery. A small amount of textile machinery was sent to China. The increase in the imports of machinery into the United Kingdom are stated merely to reflect the bias of minor industries for foreign specialities, and not any weighty development.

Aero-engines.

Aero-engines of Coventry manufacture are in world-wide demand, and the industry is becoming more and more an important asset to the city. The makers have now secured further substantial orders for the supply of engines to Switzerland and Sweden. Two Swiss air lines, operating from Zurich and Basle, have placed orders for engines of the seven-cylinder air-cooled type, developing 220 H.P., for trans-Alpine service. Similar engines have been supplied to the Dutch and Italian air lines. The order secured from Sweden is for the fourteen-cylinder air-cooled radial engine, developing 700–750 H.P.

Heavy Edge Tools.

Black Country manufacturers of heavy edge tools report that trade keeps fairly constant, though the position in the East is not altogether satisfactory. Orders from Australasia are improving, and business from South America is more regular than was the case just before Christmas. One Wolverhampton firm has considerable works extensions on hand.

Unemployment.

Unemployment in the Midlands is gradually decreasing, the position having become better each week since the resumption of activities after the Christmas holidays. The latest returns record a fall of over 3000 on the week, bringing the total to 196,135. To this total the Birmingham area contributes 28,062; the Stoke-on-Trent area, 24,638; and Nottingham, 10,092. There are now 2404 unemployed at Coventry, while the figures for the Black Country towns are:—Bilston, 2564; Cradley Heath, 3667; Dudley, 3509; Oldbury, 1329; Smethwick, 2743; Stourbridge and Brierley Hill, 3515; Tipton, 1891; Walsall, 6057; Wednesbury, 2500; West Bromwich, 2772; Wolverhampton, 6663.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Foreign Trade in Textile Machinery.

THE closing month of the year witnessed the usual seasonal decline in shipments of British textile machinery, the falling off affecting virtually all markets. In the aggregate the exports of this class of engineering product in December amounted to no more than 9748 tons, of a value of £876,667, compared with 11,871 tons, valued at £1,001,650 in the previous month, and 9060 tons, valued at £920,655 in December, 1927. The shipments during the month under review included 6958 tons of spinning and twisting machinery, of a value of £645,081, and 2381 tons of weaving machinery, valued at £170,129. British India continues to occupy the premier position among the overseas markets, exports thence during the month attaining a total value of £288,543. The next in importance of the individual markets was France, with £67,647; followed by the Netherlands with £59,621; Germany, £54,147; South American countries, £49,378; China, £45,065; Japan, £39,961; the United States, £35,442; Russia, £20,162; and Australia, £19,239; the total shipments to "other countries in Europe" amounting to £173,563.

Hopes Disappointed.

Although the past year's exports of textile machinery are not very much below the level of 1927, the fact that they are not actually well above those of the previous year is a disappointment. The monthly shipments in the first half of 1928 were at a consistently high level, and were easily in advance of those of the corresponding period of 1927. A gradual tapering off in the later months, however, was responsible for the net decline. Altogether the year's exports amounted to 125,211 tons, valued at £11,623,480, compared with 119,299 tons in 1927, of a value of £11,739,232, and 101,541 tons in 1926, valued at £9,957,259. Last year's total was made up chiefly of 645,081 tons of spinning and twisting machinery, valued at £8,700,067, and 170,129 tons of weaving machinery, valued at £2,076,339. As before British India is by far the biggest market, with takings valued at £2,824,519. Germany followed with £1,009,383; then Japan, £930,038; Russia, £900,278; the Netherlands, £742,032; France, £724,431; South America, £615,051; the United States, £429,009; China, £268,441; and Australia, £199,552. "Other European countries" accounted for aggregate imports valued at no less than £2,481,512.

The Year in Engineering.

The major engineering events of the past year are reviewed in the report for 1928 presented at the annual meeting of the Engineering and Metals Section of the Manchester Chamber of Commerce, at which Sir Benjamin Longbottom was re-elected chairman, Mr. L. F. Massey vice-chairman, and Mr. Harry Alcock honorary secretary. The view of the executive committee is that the year 1928 has been one of slight progress over the previous year. The shipbuilding industry showed a greater tonnage in the vessels launched on the Clyde and on the North-East Coast, and there was also a greater indicated horse-power in the machinery constructed. During the closing months there were more orders placed, and the prospects of the industry for the first few months of 1929 are brighter. Conditions in the textile machinery industry have been patchy, and in some sections 1928 was worse than 1927. In other sections, however, quite a noteworthy volume of business has been done with Russia, and important orders have been executed for other foreign markets. Constructional engineering during the year has been fairly active.

Machine Tools and Locomotives.

The Committee's view concerning machine tools is that the industry has had a somewhat better time than for several years. Its trade exhibition has had a stimulating effect and welcome orders have resulted. The year 1928 has been good as regards orders for locomotives for both home and abroad, and it is gratifying to note that the British locomotive is recognised as the one giving the greatest economic value in the long run, although the initial prices may be higher than those of foreign makers. The electrical engineering section has not been quite so busy in 1928 as in the previous year. This section of the industry has, however, a considerable security for its future in the national electricity scheme. The first steps of the Government's proposals to offer rating relief to industry have now been taken, and these will provide some measure of relief to the burden of standing charges to the engineering industry as a whole. Important amalgamations of interests in various sections of the engineering industry were announced in the closing months of the year, and these, with their internal economies, will contribute to a greater degree of stability.

Birkenhead's New Bridge.

A new 80ft. bridge between the Alfred Dock and the East Float Dock, Birkenhead, was placed in position on Monday of this week, and is expected to be open for traffic within the next week or two. The bridge carries a 24ft. roadway, flanked by footpaths on either side, and weighs about 870 tons. The bridge work and the widening of the channel between the two docks form part of the £1,250,000 dock development scheme which is being carried out at Birkenhead.

Local Contracts.

Among engineering contracts secured by local firms are an order for switchgear placed by the Irish Free

State Electricity Supply Board with the Metropolitan Vickers Company, Manchester, in connection with the Shannon scheme, and one by the Central Electricity Board, placed with Ferranti, Ltd., Hollinwood, near Manchester, the latter forming part of the £400,000 contract for 132,000-volt transformers for the South-East England scheme.

Non-ferrous Metals.

With the exception of tin, which has experienced a further sharp set-back, the other sections of the non-ferrous metals market have been steady to firm during the past week. Although on balance English tin has shown little alteration, there has been a fall of nearly £3 a ton in the case of foreign metal. The demand has been on a moderate scale, but there is little doubt, in view of the fact that the metal has lost in the neighbourhood of £16 since the beginning of December, that buying interest, except of a purely speculative nature, is tinged with a good deal of caution. In spite of the fact that the recent heavy buying of copper has served to cover early needs on the part of consumers of the metal, and that, in consequence, there has been a falling off in new business, quotations are firmer on balance, with both cash and forward over £1 a ton up on the week. In the case of lead, a fair weight of buying has had a distinctly firming influence, and the loss recorded a week ago has been fully recovered. Spelter has not been a particularly eventful section. At one period prices recorded a relatively substantial advance compared with those current a week ago, but on a quiet call for the metal there has since been a loss, leaving values pretty well where they were.

Iron and Steel.

Firmness continues to characterise the iron and steel markets generally, and there has been no giving way on prices this week. So far as pig iron is concerned, however, there has been little indication up to the present of the demand locally broadening out to any appreciable extent, although makers are hopeful of a renewed buying movement in the near future. One or two new contracts for several hundreds of tons in each case have been reported, but they have been relatively few. The tone of the market is strong and a certain Staffordshire firm has this week pushed up the price for delivery in the Manchester area to 70s. per ton. At the moment of writing, however, this appears to be an isolated instance, and the majority of firms in the Midlands seem to be content for the time being to maintain rates in the neighbourhood of 68s. West Coast hematite iron is fractionally dearer at 82s. 6d. per ton, delivered Manchester, but Middlesbrough is unchanged at 79s., as is also Scottish at 87s. 6d. to 90s. Finished iron is steady though only in moderate request at £10 for Lancashire Crown bars, and £9 10s. for second quality material. With regard to steel, there is a particularly insistent demand for bright drawing bars, with a moderate early delivery call for constructional steel, and a certain amount of buying of acid boiler plates, with prices firm all round at recent rates. There is still only a comparatively quiet demand about for imported steel products. Continental finished products, however, remain very firm, while the pronounced scarcity of "semis" has resulted in a further stiffening of prices, to the extent of about 2s. 6d. per ton, for billets and sheet bars.

BARROW-IN-FURNESS.

Hematite.

There is very little fresh to report about the hematite pig iron market, which continues to be fairly active. Trade is not as large as it has been in the last few years, but still it is better than it has been for months. The demand on home account is still steady, and there are a number of inquiries. Special qualities of iron are receiving attention, which is not confined to this country, for there were shipments to the Continent and to Philadelphia last week. The demand on local steel account continues, and is accounting for a fair tonnage of iron. The iron ore trade is steady, and there is a rather better business with iron producers outside the district. Foreign ore is being imported in moderate amount at present. The steel trade is not bright, and makers are finding it difficult to secure orders at anything like a price that will show a profit. The rail departments are engaged, but fresh orders will soon be required to keep the mills going.

Shipbuilding.

The two orders which Vickers-Armstrongs have booked are welcome at Barrow. The depôt ship for Chile will, it is understood, be over 400ft. long, and will provide a good amount of work considering its type. Two depôt ships for the British Admiralty are at present being built by Vickers-Armstrongs at Barrow, but they are a much larger type. No information is at present available as to the size of the gunboat ordered by the Government of Siam. At present there are about thirteen thousand workpeople employed by Vickers-Armstrongs at Barrow.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

SOME improvement is reported in the steel trades of Sheffield and district, but it does not affect the heavy side to any noticeable extent. At the open-hearth plants, work is on much the same scale as before the holiday stoppage. While, however, brisk business is being done in basic steel, the acid department remains quiet. The plants devoted to the production of railway axles, tires, and springs, which use a large proportion of the acid steel produced, are still only moderately employed. They have a fair amount of work on hand for overseas, but little from the home railway companies. The latter have, however, obtained tenders for twelve months' supplies, and an increase of business is looked for. The latest railway order to be reported, affecting Sheffield, is one for sixty-five large bogie carriages for the Siamese Railways. Of these, thirty will be built at the Nottingham works of Cammell Laird and Co., Ltd., and the remainder by Craven's Railway Carriage and Wagon Company, Ltd., Sheffield, and the Metropolitan Carriage and Wagon Company, Ltd., Birmingham. The contract was secured in competition with continental firms. There is a good deal of work on hand in Sheffield in the manufacture of special buffers.

Other Departments.

There is an insufficiency of work at the rolling mills and forges, where the New Year has not opened at all well. In other directions there are instances of full-time working; at any rate, of individual departments. One of the brightest sections is that concerned with specialities in steel. There is an increasing call for materials capable of withstanding abnormal stresses, corrosion, and other destructive influences. Sheffield, of course, produces a great range of alloy steels, and is therefore equipped, to a unique degree, for meeting such requirements. There are indications of a steady expansion in the demand for a good many descriptions of steel. At the ironfoundries, quietness is reported, and there is a good deal of short time at works making stove grates and builders' castings generally.

Old Firm Changes Hands.

The old firm of Jonas and Colver, Ltd., has been bought from the receiver by Mr. S. C. Goodwin, on behalf of the Neepsend Steel and Tool Corporation, Ltd., Sheffield. Jonas and Colver's was founded in 1870, and was amongst the first in the market with high-speed steel. In January last year, owing to losses sustained during the coal strike, it had to obtain additional financial assistance, and it was announced then that negotiations were pending. The intention of the purchasers is to continue the business as a separate company, and to form a new company under the old name as early as possible. The manufacture of "Novo" and other high-grade steels, for which the company has been noted in the past, will be continued, maintaining the quality of the various steels, and thus preserving the important reputation that the company has hitherto enjoyed.

The Lighter Side.

There is nothing very satisfactory about the position of the cutlery and plate trades. There has not yet been a full resumption of work at the cutlery factories, and travellers who are preparing for their journeys are not very optimistic as to the prospects of business with shopkeepers, either metropolitan or provincial. There is a good sale for spoons and forks, and large orders have been placed for the cheap classes of goods sold in bazaars. The export trade in cutlery has been growing for several years, and last year again showed an advance, the total value of £1,179,954 being £100,000 more than that of 1927 and £150,000 in excess of 1926. Safety razors and blades, representing £330,000, recorded the largest increase. There was also an improvement in the export of ordinary razors and scissors. Cutlery imports also showed an increase, the figures being £328,541 in 1926, £426,841 in 1927, and £469,034 in 1928. A new industry is being established in the city by Sheffield Steel Products, Ltd., of Templeborough Works, which has acquired the sole manufacturing rights in the United Kingdom of the Wistoft (Copenhagen) slot delivery machines. The machines will be made at Templeborough of British material. In addition to cigarettes and chocolates, they will deliver safety razor blades, small articles of cutlery and hardware, and other commodities. The design embodies protective devices against pilfering and the use of spurious coins. The machines will be marketed by a company which is being formed under the style of British Automatic Vendors, Ltd., at 60, Holborn-viaduct.

Army Razors.

It is officially stated that the War Office has concluded a contract with Gillette Safety Razor, Ltd., Great Portland-street, London, for the supply of 46,000 safety razors for the Army. The razors will be made entirely of British materials. The holders will be manufactured at Slough, and the blades at Montreal. Sheffield steel will be used for the blades.

Sheffield Furnace for Spain.

The largest Greaves-Etchells electric steel-melting furnace ever made has just been completed by Watsons (Metallurgists), Ltd., Sheffield. It has a capacity of 30 tons, and is being supplied to a steel works in Spain, where it will replace an open-hearth furnace.

Grimsby's New Dock.

The Corporation of Grimsby has decided to promote a parliamentary Bill to give it the necessary powers to build the new fish dock, to which reference has previously been made. The estimated cost of the dock is £1,418,000, and the Corporation seeks powers to borrow this sum, together with the amount necessary to pay the cost of passing the Bill through Parliament, and to pay interest on the money borrowed until the completion of the works, or, alternatively, for five years, whichever shall be the earlier. The dock is to be built by the Corporation and leased to the London and North-Eastern Railway Company, which will repay the cost by thirty annual instalments. At a town's meeting, the Deputy Mayor said that the original estimate of the cost of the dock was £1,250,000, but certain additions and alterations had been made to meet the views of the trawling industry, and the estimate now was £1,418,000, but the company was willing to limit the Corporation's share to £1,250,000.

Water Supply.

Bakewell Rural Council has decided to ask the Ministry of Health for sanction to borrow £14,500 for the purpose of constructing a storage reservoir for the supply of water to Hathersage. The reservoir will hold 280,000 gallons, and the water will be taken from the Sheffield Corporation, which recently acquired a moorland watershed near Hathersage.

NORTH OF ENGLAND.

(From our own Correspondent.)

Foundries Close Down.

SINCE the general strike the North of England has had few industrial disputes. Through a difficult and disheartening period employers and workers have pulled together. Now that the trade outlook is much better there is a rift in the lute caused by a dispute with the members of the National Union of Foundry Workers, who have come out on strike against a proposed reduction of 5 per cent. in wages. A number of small foundries in this area are affected, and several have been compelled to close down. In the case of the Acklam Foundry, Middlesbrough, of J. and R. Ritchie and Co., orders amounting to over £2000 have been cancelled by the firm already, and it is expected that it will be obliged to cancel many more. Other foundries are in a similar position, and when the men return the employers will be able to find work for only half the former number of hands.

Cleveland Iron Trade.

More encouraging accounts are given of the Cleveland pig iron trade. Business is broadening out on a satisfactory scale, and there are welcome signs of some early expansion of overseas trade. To meet the growing needs of local steelworks, output of basic iron may be increased shortly. The bulk of the make of Cleveland pig iron continues to be conveyed in its molten state to producers' own consuming departments. The surplus output is run into the pig beds, and with the small stocks at makers' yards, is available for disposal in the open market. Customers continue their efforts to secure price concessions, but despite the comparatively low rates at which pig iron from other home districts is offered, Cleveland ironmasters hold firmly to their fixed minimum quotations, viz.:—No. 1 foundry, 68s. 6d.; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; and No. 4 forge, 64s. 6d.

More Shipbuilding Orders.

It is announced that Smith's Dock Company, Middlesbrough, has booked a contract for six grain steamers for the Canadian Lakes. The firm has now orders in hand for no fewer than twenty-nine vessels, and although the tonnage is small, it is considerable in the aggregate, and will keep the Tees yard working at full capacity well into next year.

Hematite Pig Iron.

Conditions in the East Coast hematite pig iron trade are little altered. Moderate but steady home and overseas requirements absorb the increased supply, and as exporters are prepared to buy more freely if early delivery can be guaranteed, further enlargement of production would be welcome. Contracts are usually arranged at about the equivalent of ordinary qualities at 71s.

Ironmaking Materials.

Imports of foreign ore under running contracts continue on a heavy scale, but new business is on quiet lines. Buyers' and sellers' ideas as to values still differ widely. Merchants are not prepared to entertain offers at below the basis of best Rubio at 22s. 6d. c.i.f. Tees. Consumers of blast-furnace coke are less inclined to bargain for supplies, but are still reluctant to commit themselves heavily for forward delivery. Good average qualities are 17s. 9d. delivered to works on the North-East Coast.

Manufactured Iron and Steel.

A good rate of production is being maintained in the manufactured iron and steel trade, and producers expect to be kept busy for many months. Specifications for shipbuilding requisites should come forward freely; there is promise of further substantial buying of railway material, work in constructional engineering shops seems likely to be more plentiful, and sheet manufacturers are not only heavily sold, but are still receiving extensive inquiries. Business in semi-finished steel is quite active. Prices all round are firm.

The Coal Trade.

It is a long time since the outlook for the Northern coal trade was so cheerful as at present. The demand has expanded substantially, and now orders cannot be cleared off quickly enough. Prices are better by a shilling per ton in some instances, but it would be more encouraging to know if the higher figures were being paid by customers abroad. It is more likely that once again the increase is coming out of the exporters' pocket on old commitments. The colliery position is stronger in both Northumberland and Durham than it has been for a long while. All producers have full order books, and exporters with commitments and fresh inquiries to deal with find the present circumstances very difficult. Every grade of fuel is in better demand. The most notable advances are in respect of average classes of coking coal, second-class gas and ordinary bunkers, all of which could be bracketed at about 14s., whereas the earlier quotation was 13s. 3d. to 13s. 6d. There are qualities of coking coal which for prompt shipment have gone up a shilling per ton since the year opened. Best qualities of large steam coal in Northumberland are very scarce for any early date of shipment, and other descriptions are finding a ready market. Durham large steams are also in strong request, and the superior makes of gas fuel are being easily disposed of. In all sections of the coke trade the position is steadily firming up. Gas coke makers report heavy booking and stemming, and have difficulty in meeting the current demand, which is simply limited by export facilities. Stocks are slowly

decreasing, and prices are steady at 18s. 6d. Patent cokes are 18s. 6d. to 19s., and beehive and special qualities 23s. 6d. to 28s. 6d.

SCOTLAND.

(From our own Correspondent.)

Markets Unchanged.

So far as the steel, iron and coal markets are concerned, there has been little or no change reported since the New Year holidays. Many profess to see a turn in the tide of trade, and while there may be some slight justification for such a view, there does not appear to be any more importance attached to it than might have been imputed to numerous similar statements of opinion expressed within recent years, engendered almost wholly by a sudden but temporary spurt in any one staple industry. At the same time, the hope always arises that the latest movement may be the beginning of the long-looked-for trade revival. There certainly would appear to be a better feeling in trade circles, but up to the present actual business hardly warrants a feeling of optimism.

Steel.

Those steel works catering for shipbuilding materials are busier than they have been for some time past. The demand for plates is comparatively good, and in excess of that for sections. Steel sheet makers are passing through their quiet period, but are, however, fairly well off for orders for light sheets and galvanised descriptions. Tube makers are very active at present. The better outlook in the shipbuilding trade is having an effect on the steel trade, slight as yet, but sufficient to instil more confidence in the trade regarding the outlook for the next few months.

Iron.

Bar iron is dull and uninteresting. Re-rolled steel bars continue to do a fair turnover, but the outlook is uncertain in view of possible developments over wages and hours questions. Bar iron is nominally unchanged, and re-rolled steel bars are firm at £7 15s. home and £7 10s. to £7 15s. per ton export. Pig iron has a very restricted demand, which is easily arranged for, although outputs are meagre.

Wrought Iron and Steel Re-rolling.

Negotiations between employers and men in the wrought iron and steel re-rolling trades having broken down, notices have been posted at all the works to the effect that all existing agreements would be cancelled within a fortnight. In the meantime the employers hold themselves in readiness to make fresh agreements with their employees.

Exports and Imports.

During the week 9800 tons of iron ore, 1000 tons of pyrites, 1500 tons of manganese ore, 500 tons of pig iron, and 3000 tons of steel and iron products were unloaded at Glasgow Harbour. Shipments of steel and iron amounted to 4000 tons, and of pig iron to 193 tons.

Coal.

So far as the shipping department is concerned new business is exceedingly scarce, but in view of restricted supplies and increased home demands, the market remains strong and firm prices are obtained for the small parcels changing hands to complete shipments. Lanarkshire splints and Fifeshire first-class steams are especially strong. As a matter of fact, treble nuts are almost the only description showing any signs of weakness at present. Aggregate shipments amounted to 221,697 tons, against 197,737 tons in the preceding week and 254,986 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE position in the steam coal industry continues to be comparatively good, inasmuch as practically all collieries are working well and are very fully booked up for the remainder of this month, while many of them have no coal to spare until the second half of February. As a matter of fact, it is surprising to find how tight most coals are for anything like early shipment. The demand is by no means confined to the foreign coaling depôts, but appears to have improved all round. Many orders are held up temporarily for the simple reason that exporters are unable to execute them, as the coals cannot be obtained. The returns of shipments for last week were below expectations, as the quantity was just under 420,000 tons, but the probabilities are that the figures for this week will register an advance, notwithstanding that the tonnage available at the beginning of the week was not as large as had been looked for. There is a good supply to come along in view of recent chartering, though the amount of tonnage now being taken up is restricted, owing to the fact that collieries are unable to take much more on for loading during the next fortnight. The general position for the next month is satisfactory, and it would be no surprise if the existing conditions were well maintained right up to Easter. In view of the improvement, one or two collieries are opening up fresh places, thus providing employment for more miners, but this is rather the exception. The conditions have not become so much better as to justify wholesale reopening of the pits that have been closed owing to depression. Such extension of working must be a very gradual process as trade further expands. No news has yet been received regarding the placing of the Egyptian State Railways' requirements or the order for the Navagazione Generale Italiana, but the French Marine authorities are inquiring for prices for about 50,000 tons of Admiralty large coals for delivery at their various naval bases during the next seven months.

Egyptian State Railways' Tenders.

News came to hand during the latter part of last week respecting the tendering for the locomotive coal requirements of the Egyptian State Railways, amounting to 200,000 metric tons, for delivery at Alexandria between February and May. The lowest price submitted was 28s. 5½d. c.i.f. Alexandria, for 70,000 tons, by T. Beynon and Co., and the next was 28s. 6d. c.i.f. for 200,000 tons, put in by Watts, Watts and Co.; while other prices for Welsh coals ranged up to 30s. 9d. c.i.f. The lowest price tendered for Northumberland coals was 25s. 7½d. c.i.f., put in by Watts, Watts and Co., and offers were submitted by other firms for Westphalian coals at 28s. 7d. and 29s. 1½d. c.i.f. Naturally the prices submitted for Welsh coals are higher than the figure at which the last contract was concluded at, viz., 27s. 1d. c.i.f. Fears have been expressed in some quarters that the order on this occasion might go to the North, but this is scarcely likely to be the case, inasmuch as the difference in prices as compared with those for Welsh coals is less than it was when tenders were called for last time. If the margin in price were greater there would then be some justification in the authorities giving more consideration to North Country coals. The rumour has been current of late that the Egyptian State Railways had recently placed a contract for 130,000 tons of Polish coals, and that it was for this reason that they reduced the quantity of coals to be tendered for from 340,000 metric tons to 200,000 metric tons, but reports to hand state that there is no truth in the report. The present tenders have to hold good for ten days from the 17th inst., when they were opened at Cairo.

Coal-loading Facilities.

There is a prospect of extended facilities for the loading of coals in this district, as the result of negotiations which are now in progress. Such an extension is greatly to be desired, especially in times of pressure, and considering the fact that in other coal-exporting centres steps have already been taken to this end. A joint meeting of representatives of the South Wales Area Board and representatives of the trimmers and tippers and the Great Western Railway Company was held at Cardiff on Monday, when the employers submitted proposals which were fully discussed, after which an adjournment was made until February 4th, so as to enable the representatives of the men to confer with their members in the meantime. The proposals of the employers are that two hours' overtime should be worked in continuation of each day and night shift other than Saturday when required to enable a vessel to sail; payment for such overtime to be at the rate of 1s. 6d. per man per hour, in addition to the tariff rates. On Saturdays overtime is to be worked from 12 noon to 4 p.m. when required to complete loading to enable a vessel to sail; payment for such overtime on Saturdays to be at the rate of 2s. 6d. per man per hour, in addition to the tariff rates. The same men engaged on the shifts are to be employed for overtime work. The tippers being the employees of the Great Western Railway Company, negotiations for payment of tippers' overtime are to be arranged by the G.W.R. Company and the tippers' representatives.

Current Business.

The tone of the steam coal market is quite firm in all departments, owing to the loading pressure which is being experienced, and the fact that most colliery undertakings are well sold for the remainder of this month and the early part of next. Large coals are for the most part 3d. to 6d. above the minimum schedule prices, while smalls command 6d. to 9d. per ton above the minimum prices. The quantity of coals which collieries have to spare is, however, comparatively small. Coke is very steady, while patent fuel makers are better off for orders. The pitwood market has improved.

Tin-plate Trade.

It has been decided to continue the scheme for the restriction of output for the quarter beginning February 24th next, and as a consequence a more confident tone prevails, it being expected that buying will be on a more active scale.

CATALOGUES.

GUMMERS, Ltd., Rotherham.—Brochure on forged steel valves.

J. P. HALL AND CO., Ltd., Oldham.—Booklet No. 64 of motors and dynamos of all classes.

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—Brochure on the "Prescot" wiring system.

JOHN CASHMORE, Great Bridge, Staffs. — Catalogue of machinery and plant of all types in stock.

WELDLESS CHAINS, Ltd., Gartsherrie, Coatbridge.—Particulars of weldless chains, lifting clamps, slings, dogs, &c.

BLACKSTONE AND CO., Ltd., Stamford.—Publication No. 450, giving details of 1, 1½, 2½, and 3½-kW electric lighting plants.

TANGYES, Ltd., Cornwall Works, Birmingham.—Production booklet No. 359, giving a brief outline of the firm's products.

PLENTY-STILL OIL ENGINES, Ltd., King's-road, Newbury.—A catalogue dealing in detail with various types of the "Still" oil engine.

SAMUEL PEGG AND SON, Leicester.—A book entitled "From Quarry Face to Road Surface *viâ* Pegson Plant," dealing in detail with the firm's products.

VACUUM OIL COMPANY, Ltd., Caxton House, London, S.W. 1.—No. 31 of the "Gargoyle" technical series, entitled "The Lubrication of Wood-working Machinery."

THE PATERSON ENGINEERING COMPANY, Ltd., Windsor House, Kingsway, London, W.C. 2.—A booklet of one hundred pages dealing with water sterilisation by gaseous chlorine.

THE BRITISH ROPEWAY ENGINEERING COMPANY, Ltd., 14 to 18, Holborn, E.C. 1.—A sixty-four-page booklet, giving particulars and illustrations of ropeways installed in various parts of the world.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., 82, York-road, King's Cross, N. 1.—The second edition of "Double Wire Signalling for British and Colonial Railways."

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester.—Special Publication 7976/01, dealing with a number of electric locomotives supplied during the past few years.

H. AND T. DANKS (NETHERTON), Ltd., Netherton, Dudley.—A folder illustrating in a convenient form the firm's products, which include boilers, chimneys, coalwashing and screening plant, press work, &c.

BLACKMAN EXPORT COMPANY, Ltd., 374, Euston-road, London, N.W. 1.—Section E. 9/809, which deals with Blackman air heaters. Full particulars as to dimensions, &c., are embodied in the list.

THE DEMOLITION AND CONSTRUCTION COMPANY, Ltd., 72, Victoria-street, S.W. 1.—A brochure dealing with the hydraulic cartridge for the breaking up of large masses of concrete where explosives cannot be used.

MERRYWEATHER AND SONS, Ltd., Greenwich-road, S.E. 10.—Catalogue of the Merryweather portable water-tube boiler, made in standard sizes for outputs from 2 to 200 H.P. and operating on practically any type of fuel; also a catalogue dealing in detail with the "Hatfield" trailer fire pump.

ALLOY WELDING PROCESSES, Ltd., 14, Church-street, N. 1.—The following bulletins:—"The Laying of Pipe Lines and A.W.P. Electrodes;" "A German Opinion of A.W.P. Electrodes;" "A New Electric Welding Dynamo;" "Applications of Electric Arc Welding to the Repair and Maintenance of Machinery on Board Ship."

PICKFORDS, Ltd., 151, Tower Bridge-road, London, S.E. 1, Birmingham and Manchester.—An illustrated brochure of the firm's heavy haulage department. The matter of dismantling, loading, erection, unloading, boiler setting and lifting of every description is dealt with. This brochure may be obtained in the French and German languages.

LAUNCHES AND TRIAL TRIPS.

FERNMOOR, twin-screw cargo motor ship; built by Burmeister and Wain, Ltd., to the order of Rederiaktieselskabet "Glittre" (Messrs. Fearnley and Eger), Oslo; dimensions, 380ft. by 53ft. 6in. by 36ft.; to carry cargo. Engines, two six-cylinder four-cycle Diesel engines; constructed by the builders; a speed of 15·54 knots was attained on trial trip, December 21st.

CELTIC MONARCH, steel screw cargo steamer; built by David and William Henderson and Co. to the order of Monarch Steamship Company, Ltd.; dimensions, 430ft. by 56ft. by 30ft. 6in., of about 9500 tons deadweight. Engines, quadruple-expansion, 25in., 35½in., 51in. and 72in. by 51in. stroke, pressure 220 lb. per square inch; constructed by the builders; trial trip, January 7th.

STEAMSHIP; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Mr. J. J. Boland, jun., and Captain R. S. Misener, Canada; dimensions, 253ft. long; to carry cargo. Engines, inverted marine type; constructed by the builders; launch, January 10th.

VACUOLINE, oil tank vessel; built by Lithgows, Ltd., of Port-Glasgow, to the order of Vacuum Oil Company, Ltd.; dimensions, 460ft. 6in. by 62ft. 6in. by 36ft. 6in.; to carry petroleum in bulk. Engines, inverted direct-acting quadruple-expansion, pressure 230 lb. per square inch; constructed by David Rowan and Co., Ltd.; a speed of 12 knots was attained on trial trip, January 14th.

OILRELIANCE, single-screw motor tank vessel; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of British Oil Shipping Company, Ltd., London; dimensions, 424ft. by 53ft. 5in.; to carry 8600 tons oil cargo. Engines, one set seven-cylinder "Neptune" Polar Diesel engine; constructed by the builders; a speed of 12½ knots was attained on trial trip recently.

OPHIR, twin-screw motor passenger ship; built by Netherland Shipbuilding Company, to the order of Koninklyke Paketvaart Maatschappij; dimensions, 386ft. 6in. by 51ft. 6in. by 23ft.; to carry passengers. Engines, two eight-cylinder single-acting four-cycle Diesel motors; constructed by Werkspoor; trial trip, recently.

ALONA-MENDI, steamer; built by Wm. Gray and Co., Ltd., to the order of La Compania Naviera Sota. Y. Aznar, of Bilbao; dimensions, 289ft. by 39ft. by 18ft. 2¼in.; to carry cargo. Engines, triple-expansion, 20½in., 33½in., 55in. by 39in. stroke, pressure 180 lb. per square inch; constructed by the builders; trial trip, January 18th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

STERNOL, Ltd., requests us to announce the death of its Chairman, the Right Hon. Lord Athlumney, who had occupied the position since the close of the War.

AVELING AND PORTER, Ltd., of Rochester, and Barford and Perkins, Ltd., of Peterborough, ask us to announce that an arrangement has been come to between them by which the home sales of all new public works plant made by the two firms will be handled by a joint company, entitled Aveling and Barford and Perkins (Sales), Ltd., with its office at Aldwych House, Aldwych, London, W.C. 2, to which it is requested that all inquiries for new public works plant should in future be sent.

INSTITUTION OF ELECTRICAL ENGINEERS.—The next examination for Associate Membership of the Institution of Electrical Engineers will be held on May 29th, 30th and 31st, 1929. Candidates must (*a*) be either Students or Graduates of the Institution, or (*b*) have lodged with the Secretary a duly completed form "E" for election as Associate Member and have been informed that they must pass the examination as a condition of election. Entry forms for the examination, which must be completed and returned by April 1st, and particulars regarding election to membership of the Institution may be had on application to the Secretary, The Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2.

THE IRON AND STEEL INSTITUTE.—At the Autumn Meeting of the Iron and Steel Institute at Bilbao, Professor Henry Louis, M.A., D.Sc., was unanimously nominated for election as the next President of the Institute, and he will take office at the Annual Meeting in London on May 2nd, 1929. Professor Louis being a prominent citizen of Newcastle-upon-Tyne, the members resident in that neighbourhood considered that it would be very appropriate to hold the Autumn Meeting in that city, during Professor Louis's presidency. We are informed that the Lord Mayor and Corporation of the City of Newcastle-upon-Tyne have sent a cordial invitation to the Council of the Institute to hold the meeting there, and the date has been fixed for September 10th–12th, 1929.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	17/6 to 19/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 15 0	—
No. 1 Foundry	3 15 0 to 3 16 0	—
No. 3 Foundry	3 10 0 to 3 11 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 11 0	3 11 0
No. 1	3 12 0	3 12 0
Cleveland—		
No. 1	3 8 6	3 8 6
Silicious Iron	3 8 6	3 8 6
No. 3 G.M.B.	3 6 0	3 6 0
No. 4 Foundry	3 5 0	3 5 0
No. 4 Forge	3 4 6	3 4 6
Mottled	3 4 0	3 4 0
White	3 4 0	3 4 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
,, ,, Foundry	3 2 6	—
(3) Northampton—		
Foundry No. 3	2 15 0 to 2 16 0	—
Forge	2 11 6 to 2 12 6	—
(3) Derbyshire—		
No. 3 Foundry	3 0 0 to 3 1 0	—
Forge	2 16 0 to 2 17 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 0 6	—
No. 4 Forge	2 17 6	—
Basic	3 0 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 0 0 (*a*); 4 3 6 (*b*); 4 6 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 5 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
Double Best Bars	11 5 0	—
Treble Best Bars	11 15 0	—
Lancs.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	10 10 0	—
Best Bars	11 0 0	—
Hoops	12 10 0	—
Midlands—		
Crown Bars	9 2 6 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 10 0 to 8 17 6	—
Gas Tube Strip	10 12 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 15 0	8 12 6
Sheets (Gal. Cor. 24 B.G.)	13 10 0	13 12 6 to 13 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	7 12 6	—
Soft Billets	6 15 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0	—
Light Rails	8 5 0 to 8 10 0	—
Billets	6 15 0 to 9 10 0	—
Manchester—		
Bars (Round)	8 17 6	—
,, (Small Round)	8 0 0 to 8 2 6	—
Hoops (Baling)	10 0 0	9 15 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 12 6 to 8 17 6	—
,, (Lancs. Boiler)	9 12 6 to 9 17 6	—
Sheffield—		
Siemens Acid Billets	9 0 0	—
Hard Basic	8 15 0	—
Intermediate Basic	7 5 0 to 7 15 0	—
Soft Basic	6 12 6	—
Hoops	9 5 0 to 9 10 0	—
Soft Wire Rods	7 15 0	—
Midlands—		
Small Rolled Bars	7 15 0 to 8 0 0	—
Billets and Sheet Bars	6 2 6 to 6 5 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 12 6 to 13 15 0	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	9 15 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	18/- to 18/3
Block Tin (cash)	223 0 0
,, ,, (three months)	222 17 6
Copper (cash)	75 13 9
,, (three months)	73 17 6
Spanish Lead (cash)	22 3 9
,, ,, (three months)	22 5 0
Spelter (cash)	25 17 6
,, (three months)	25 16 3
Manchester—	
Copper, Best Selected Ingots	78 10 0
,, Electrolytic	80 10 0
,, Strong Sheets	102 0 0
,, Tubes (Basis Price), lb.	0 1 2¼
Brass Tubes (Basis Price), lb.	0 1 0½
,, Condenser, lb.	0 1 2½
Lead, English	23 12 6
,, Foreign	22 10 0
Spelter	26 0 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 10 0	7/6
,, ,, 6 p.c. to 8 p.c.	£20 10 0	7/-
,, ,, 8 p.c. to 10 p.c.	£20 0 0	6/-
,, ,, Specially refined		
,, ,, Max. 2 p.c. carbon	£33 0 0	12/-
,, ,, ,, 1 p.c. carbon	£37 0 0	15/-
,, ,, ,, 0·70 p.c. carbon	£42 0 0	17/-
,, ,, ,, carbon free	1/- per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home; £13 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£19 0 0 scale 6/- per unit	
,, Vanadium	14/- per lb.	
,, Molybdenum	4/3 per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/- per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	14/-
,, ,, Ell	16/6
,, ,, Splint	17/- to 17/6
,, ,, Trebles	15/-
,, ,, Doubles	13/6 to 13/9
,, ,, Singles	13/-
Ayrshire—	
(f.o.b. Ports)—Steam	13/9
,, ,, Jewel	16/6
,, ,, Trebles	16/-
Fifeshire—	
f.o.b. Methil or Burntisland—Steam	12/9 to 14/-
Screened Navigation	18/-
Trebles	14/9 to 15/3
Doubles	14/-
Singles	12/9 to 13/-
Lothians—	
(f.o.b. Leith)—Best Steam	13/6 to 14/-
Secondary Steam	13/6
Trebles	15/- to 15/6
Doubles	13/9 to 14/-
Singles	12/9 to 13/-

ENGLAND.

	Inland.
(8) N.W. Coast—	
Steams	23/-
Household	38/6 to 51/-
Coke	22/-
Northumberland—	
Best Steams	14/6
Second Steams	13/6
Steam Smalls	9/-
Unscreened	12/- to 12/6
Household	21/- to 27/-
Durham—	
Best Gas	14/9
Second	13/3 to 13/6
Household	21/- to 27/-
Foundry Coke	18/- to 19/-
Sheffield—	
Best Hand-picked Branch	26/- to 27/6
Derbyshire Best Bright House	23/- to 24/6
Best House Coal	20/6 to 21/6
Screened House Coal	17/- to 18/-
,, ,, Nuts	16/- to 18/-
Yorkshire Hards	15/- to 16/-
Derbyshire Hards	15/- to 16/-
Rough Slacks	8/6 to 9/6
Nutty Slacks	4/6 to 6/-
Smalls	3/6 to 4/-
Blast-furnace Coke (Inland)	14/6 at ovens
Furnace and Foundry Coke (Export), f.o.b.	19/- to 19/6

(9) SOUTH WALES.

Cardiff—	
Steam Coals :	
Best Smokeless Large	19/3 to 19/6
Second Smokeless Large	19/- to 19/3
Best Dry Large	18/6 to 19/-
Ordinary Dry Large	17/6 to 18/-
Best Black Vein Large	18/9 to 18/-
Western Valley Large	17/3 to 17/6
Best Eastern Valley Large	17/- to 17/3
Ordinary Eastern Valley Large	16/6 to 16/9
Best Steam Smalls	13/- to 13/6
Ordinary Smalls	11/- to 12/9
Washed Nuts	18/- to 24/-
No. 3 Rhondda Large	19/6 to 20/-
,, ,, Smalls	14/- to 14/6
No. 2 ,, Large	16/- to 16/6
,, ,, Through	14/6 to 15/6
,, ,, Smalls	11/- to 12/-
Foundry Coke (export)	27/- to 37/-
Furnace Coke (export)	19/- to 21/-
Patent Fuel	20/- to 21/6
Pitwood (ex ship)	27/- to 27/6
Swansea—	
Anthracite Coals :	
Best Big Vein Large	33/- to 35/-
Seconds	25/- to 29/-
Red Vein	22/- to 27/-
Machine-made Cobbles	40/- to 43/6
Nuts	36/- to 43/6
Beans	23/6 to 25/-
Peas	16/6 to 17/6
Breaker Duff	8/9 to 9/-
Rubbly Culm	9/- to 9/3
Steam Coals :	
Large	17/6 to 18/6
Seconds	16/- to 17/-
Smalls	9/6 to 12/-
Cargo Through	15/- to 16/-

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products

French Engineering Notes.

(From our own Correspondent in Paris.)

Battleships.

IN sanctioning an expenditure of 989 million francs upon the instalment of the naval shipbuilding programme which is to be put in hand during the present year, the Chamber of Deputies showed its determination to carry through the plans for the constitution of a homogeneous fleet of light and fast surface vessels and underwater craft in accordance with the Naval Statute presented in 1925. By the construction of the new 10,000-ton cruiser, six destroyers and six first-class submarines, one submarine minelayer, two "avisos" or light vessels for foreign and colonial stations, and two oil tankers, the programme will be half completed. But questions arise as to the expediency of sacrificing armament and protection to speed; there is no longer unanimity on this point. Even the attempt to increase the tonnage of submarines with the idea of evolving a type of submarine crusier has revealed difficulties in the way of deficient handiness and conspicuousness. The programme may, therefore, undergo a gradual change not only as the result of experience in this country but also on account of the developments taking place in foreign navies. Only one member of the Chamber of Deputies ventured to foreshadow the helplessness of the French fleet in the Mediterranean if it were confronted by half a dozen battle cruisers of the new German type. The Minister of Marine stated that the matter had not been overlooked, and, in fact, it is taken more seriously than is generally supposed, for it may mean a complete change in the preparations which have been in progress for some time past for presenting types of battleships that must be included in the later instalments of the shipbuilding programme. The French have long maintained that when the time came to build battleships they would have to restrict them to a smaller and faster type, and that is what the Germans have done; but they have set a problem that will exercise all the skill of French naval architects. By their long range of action the new 10,000-ton battle-cruisers will not only out-manœuvre the more lightly armed cruisers, but they threaten to change the strategical situation of the French navy which might be required, on account of its treaty obligations, to be able to operate in the Baltic for the protection of Poland. Hence, French naval experts are keenly alive to the necessity of counteracting the German move.

Miners' Strike.

The strike of colliers in the Loire has failed so hopelessly that it is expected to put an end to labour troubles in the coal mining industry for a long while to come. It was a final effort of the Communist Union to cause trouble in the Loire coal basin, where its influence is particularly strong; but it met with opposition from the other miners' associations, and at no time was the number of strikers more than 60 per cent. of the total. There could be no excuse for the strike, because all the unions had accepted an advance in wages, which represented the maximum that could be accorded by the coalowners, and when the oldest company in the district, the Société Houillère de Saint-Etienne, went into liquidation it was made quite clear to the men that they had gone too far. There is some hope now that the colliery industry will be able to carry out its work of reorganisation without being troubled by such disturbing influences in the future.

Airship.

After their unfortunate experience with the "Dixmude" and other airships surrendered by the Germans, the French felt that they had little cause to change their attitude towards dirigibles, which they regarded as too unreliable and as capable of rendering far less service than a number of aeroplanes that could be built at the same cost. It appeared as if the airship had been wholly rejected by the military and naval authorities. It is therefore interesting to learn that a 3000 cubic metre airship of the semi-rigid type has just been completed for the naval aviation service. If the trials are satisfactory, it is proposed to construct others of a larger type.

African Railways.

Since the contract was given to the Société des Batignolles, six years ago, for the construction of the railway from Brazzaville to the port of Pointe-Noire, in French Equatorial Africa, progress has been made under considerable difficulties, particularly on account of the labour shortage and the heavy loss of life amongst native carriers who were unable to accomplish their task in a country unsuited for transport. The use of natives for the purpose had to be abandoned, and a narrow gauge railway was pushed forward for the laying down of the normal gauge line. Even then labour was deficient, and an attempt is now being made to import Asiatic labour. The line is being constructed both from Brazzaville and Pointe-Noire. From the latter place the work is well advanced over a distance of about eighty miles, where a tunnel is being driven through the mountain range, and from Brazzaville a part of the line is already being worked. The total length will be about 330 miles. It will be of normal gauge. The mountainous character of much of the country involves the construction of many bridges, viaducts and tunnels.

Production Costs.

Statements to the effect that advances will be declared in pig iron, coke and some steels are regarded as pointing to a further rise in production costs, and it is feared that if that should continue the present year may see those costs approaching the levels of other countries, in which event French manufacturers may find themselves practically excluded from foreign markets, and may even be confronted with competition of foreign goods at home. Living costs are still below what would seem to be justified by the monetary stabilisation, but they are advancing, and, in view of the general industrial activity, and the scarcity of skilled labour, there is every prospect of costs levelling up all round.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

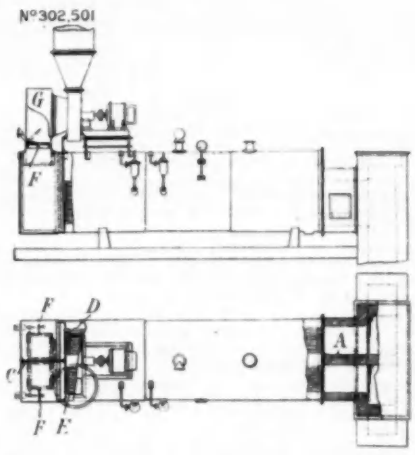
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

302,501. December 22nd, 1927.—WASTE HEAT BOILERS FOR GENERATING STEAM, Spencer-Bonecourt, Ltd., of 50–64, Broadway, Westminster, S.W. 1; and Percy St. George Kirke, of 50–64, Broadway, Westminster, S.W. 1.

This invention relates to waste heat boilers for generating steam from the hot waste products of combustion of industrial furnaces and is concerned more particularly with waste heat boilers utilising the waste heat from a number of different sources and the flue area of which is divided into separate flue passes in the gas inlet chamber of the boiler and also in the gas outlet chamber of the boiler, the gas inlet ends of the flue passes being adapted for connection with a separate source of waste heat and the gas outlet ends of the flue passes being fitted with separate dampers permitting independent control of each flue pass. A waste heat boiler is shown arranged for operation with two separate forge furnaces. The flue area in the gas inlet chamber

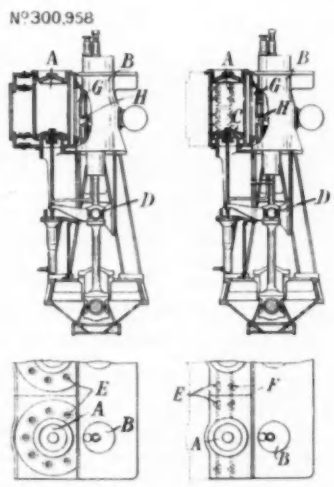


at one end of the boiler is divided by a partition wall A into two flue inlet passes and the flue area in the gas outlet chamber at the other end of the boiler is divided by a partition plate C into two flue outlet passes communicating respectively with the inlet passes through the intermediary of the nests D E of flue tubes. Dampers F fitted in each outlet pass permit independent control of the gas passes whereby to regulate the draught. The passes are connected, beyond the dampers F, with the single fan or exhauster G driven by the motor surmounting the boiler. In operation, when both furnaces are working under the same conditions, the two dampers F in the gas outlet passes may be in fully open position and the waste gases drawn through both flue circuits by the fan G. When it is necessary to reduce the draught for one furnace without interfering with the draught of the other furnace, as, for instance, to enable a reducing atmosphere to be obtained in one furnace, all that is necessary is to close the relative damper F to the desired extent.—*December 20th*, 1928.

INTERNAL COMBUSTION ENGINES.

300,958. November 5th, 1928.—IMPROVEMENTS IN TWO-STROKE CYCLE VERTICAL INTERNAL COMBUSTION ENGINES, Fried. Krupp Germaniawerft Aktiengesellschaft, of Kiel-Gaarden, Germany.

This invention relates to two-stroke oil engines of the marine type in which the scavenge pumps are arranged beside the working cylinders in order to simplify the pump drive. The object of the invention is to reduce the width of the engine at the upper

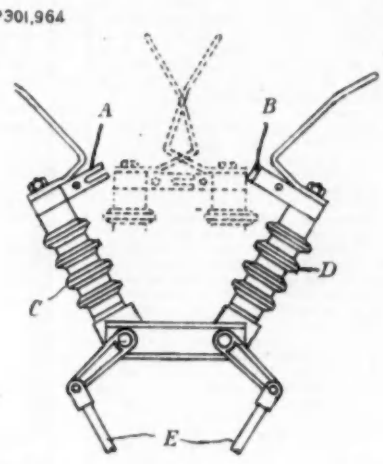


part and so to permit of wider gangways in the cabin spaces adjacent to the engine-room. In the vertical sections and part plan views reproduced herewith, the two systems are contrasted. It will be seen that the scavenge pump cylinders A are adjusted to the working cylinder B and that the scavenge pump piston C is driven by the main crosshead D. E and F signify the suction and delivery valves of the double-acting scavenge pump respectively, while G is the compressed scavenge air space and H the scavenge ports in the liner wall. In the arrangement shown on the left side is illustrated the older design in which the suction and delivery valves were accommodated in an annular belt around the scavenge pump cylinder. In the new arrangement, shown to the right, it will be seen that these valves are arranged on the vertical surfaces of an air chamber which is formed by walls running between the adjacent scavenge pump cylinders. It is claimed that in such a design not only is engine width saved, but a larger area is available for placing the valves and bigger valves can be used, thereby reducing the number of valves it is necessary to employ.—*December 20th*, 1928.

SWITCHGEAR.

301,964. August 6th, 1927.—ELECTRIC CONTROL SWITCH CONSTRUCTIONS, Fritz Berg, of 13, Kepplerstrasse, Mannheim, Germany.

The switch described in this specification is suitable for pole



mounting. The contacts A B are mounted on insulators C D, which may be swung backwards and forwards by rods E. The dotted line sketch shows the switch in the closed position.—*December 6th*, 1928.

TELEGRAPHS AND TELEPHONES.

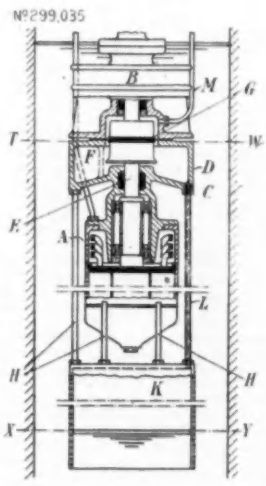
299,016. October 18th, 1928.—IMPROVEMENTS IN OR RELATING TO DIRECTION-FINDING AERIALS FOR USE ON AIRCRAFT, Telefunken Gesellschaft für drahtlose Telegraphie, m.b.H., of 9, Tempelhofer Ufer, and 12 and 13, Hallesches Ufer, Berlin.

The practice of protecting direction-finding aerials against mechanical injury and moisture by enclosing them in tubular metallic casings is well known. Hitherto, however, weather-proof constructions have only been employed for direction-finding aerials on land, on ships, and generally in cases in which aerodynamic losses do not occur or are unimportant. As a rule the protecting casings have been of circular section, and it will readily be seen that if such casings were employed for directional frames on aeroplanes the aerodynamic losses would become great. The principal object of the invention is to overcome this disadvantage. According to the invention, a protecting casing for a directional aerial for use on aircraft is formed with a streamlined profile. Aerodynamic losses may thus be reduced to one-eighth of those which occur with casings of known construction. In the case in which the directional aerial comprises double frames which are fixed relative to the aircraft aerodynamic losses may be permanently reduced to a very small amount, the protective casings being so arranged that their streamlined profiles are in that position with respect to the direction of motion in which air resistance is a minimum. With rotatable frames, on the other hand, the conditions are not quite so advantageous. Preferably in this case the casings are arranged so that their streamlined profiles offer the lowest air resistance for the position in which the frames lie across the direction of motion. It is true that for other portions of the rotatable frame the losses will be somewhat increased, but for the majority of the time they will be at a minimum.—*December 20th*, 1928.

PUMPING AND BLOWING MACHINERY.

299,035. August 27th, 1928.—SUBMERSIBLE ELECTRIC MACHINES, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

The motor A with the pump B is lowered into the bore-hole containing the liquid C. The motor shaft is carried through the



housing D and the packing gland E into the sealing chamber F, which contains the coupling G. By means of rods H a diving bell K is fixed below the motor to the housing D. Its air chamber is connected by means of the pipe L with the chamber F. A sealing air pipe M leads to the surface, and in this pipe there is

a check valve, so as to prevent the escape of air to the surface. As soon as the sinking pump is immersed below the level of the liquid, the air in the diving bell K, the pipe L, and the sealing chamber F is compressed until the air pressure is equal to the hydrostatic pressure obtaining at the level X Y. As the hydrostatic pressure at the level X Y of the diving bell K is always greater than that at the level T W of the sealing chamber F the air pressure in the sealing chamber always exceeds the hydrostatic pressure acting upon the sealing chamber, and thereby prevents the liquid from penetrating through the packing joints. If, in consequence of defective packing, liquid should penetrate to the sealing chamber, by means of the pipe L and the diving bell K it can flow back again into the bore-hole. The air stored in the sealing chamber and in the diving bell can be replenished at intervals by admitting compressed air by means of the pipe M. —*December 13th*, 1928.

MISCELLANEOUS.

302,064. December 30th, 1927.—IMPROVEMENTS IN OR RELATING TO ELECTRODES FOR USE IN ARC WELDING, Imperial Chemical Industries, Ltd., and John Hamilton Paterson, both of Broadway Buildings, Broadway, Westminster.

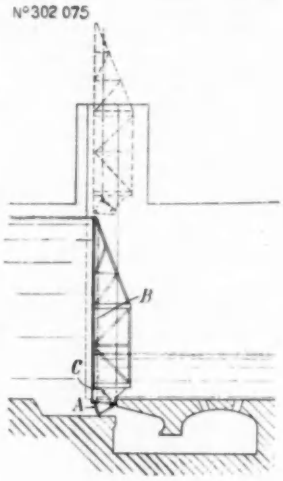
The welding electrode described in this specification is composed of metal wires A, arranged parallel to each other and welded together at points B, which may conveniently be situated apart at distances of, say, 6in. A flux may be incorporated in the electrode by inserting a number of strands C of asbestos fibre or other material between the wires, but preferably so arranged that they do not come to the surface of the electrode. The asbestos fibre may be soaked in a sodium carbonate solution to reduce its melting point or otherwise treated to modify its properties. The wires may be of any suitable metal, for example, of iron, nickel or copper, separately or in any combination. The invention is well adapted for use with a hand tool comprising a feeding device from a nozzle in which the electrode protrudes. A flexible electrode made according to the invention is claimed to have the following advantages over other electrodes made of a multiplicity of strands of wire :—Owing to the strands being parallel to each other there is no tendency for the arc to wander as it does with twisted strands or with an electrode composed of a central core with an outer wrapping of wire ; and as all the wires comprising the electrode are fused together at intervals, the welding current passing through the electrode is evenly distributed throughout the cross section and much heavier currents can be carried without causing that portion of the electrode which protrudes from the nozzle of the feeding device to become red hot. In other electrodes consisting of a number of wires wrapped together, the outer layers carry the bulk of the current, the contact between different strands being unsatisfactory.—*December 13th*, 1928.

N°302,064

302,075. January 26th, 1928.—IMPROVEMENTS IN AND RELATING TO SLUICE GATES AND THE LIKE, *Edward Charles Robert Marks, of 57 and 58, Lincoln's Inn-fields, London, W.C. 2.*

The sluice valve associated with the sluice gate shown in the accompanying illustration takes the form of a segment-shaped valve, as shown at A. The sluice gate is operated by a lifting

N°302 075

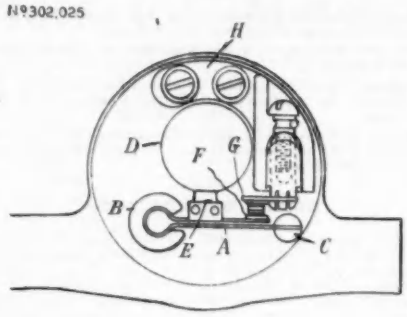


member B, which engages with the valve A at the bottom of the gate, and raises this valve first until it touches the stop C, after which the main gate is raised. The segment-shaped member of the valve may be supported at as many points as desired in the main gate. The force required for moving the segment is extremely small, and the initial cost is said to be less than that of other arrangements.—*December 13th*, 1928.

302,025. November 8th, 1927.—ELECTRIC CONTACT BREAKERS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2, and Ernest George Parrott, of "The Cottage," 6, Kenilworth-road, Balsall Common, near Coventry.

The object of this invention is to provide a contact breaker suitable for magnetos that is simple in construction, efficient in operation, and cheap to manufacture. A substantially U-shaped spring A is rigidly secured at the outer end of one limb in a slot in an anchoring pillar C. The bend portion of the spring is expanded out into substantially circular form, and is adapted to engage in a fixed guide block B. The circular portion and the block thus acts as a pivot for the free limb of the spring, which carries a contact F at its outer end. This contact is adapted to co-operate with a fixed contact, the separation of the two contacts being effected by means of a cam D operating on a contact block E. The fixed contact is arranged to be adjustable, and preferably it is mounted so that adjustment can be effected without rotation of the contact. The whole of the insulated contact assembly is carried on an insulated plate H, which is secured to the contact breaker base by means of screws. A contact breaker of this type is of very simple construction, and possesses the advantage that the spring can be simply slipped into position in the guide block and held in position therein by

N°302,025



an expanding spring ring, so that fixing screws can be dispensed with.—*December 13th*, 1928.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF LOCOMOTIVE ENGINEERS : NORTH-EASTERN CENTRE.—Hotel Metropole, Leeds. "Pulverised Fuel Locomotive," by Mr J. Clubley Armstrong. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Informal meeting. "Measurement of Coal Supplies in Small or Large Quantities," introduced by Mr. J. E. Lea. 7 p.m.

INSTITUTION OF PRODUCTION ENGINEERS.—In the Council Room of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, London, S.W. 1. "The Designer v. the Production Engineer," by Mr. L. H. Pomeroy. 8 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Notes on Winches, Derricks and other Lifting Appliances Used in Modern Building Construction," by Mr. M. J. McCarthy. 7.30 p.m.

PHYSICAL SOCIETY.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. "A Fused Quartz Pendulum Rod for Clocks," by Professor C. Vernon Boys, F.R.S.; "A Method for the Determination of the Equivalent Resistance of Air Condensers at High Frequencies," by Mr. G. W. Sutton ; "The Measurement of the Anode Circuit Impedances and Mutual Conductances of Thermionic Valves," by Mr. L. Hartshorn. 4.45 p.m. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse, "The Vegetation of Greenland," by Professor A. C. Seward, F.R.S. 9 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—In the "Societies' Room," No. 24, Royal Technical College, George-street, Glasgow. The Council will meet at 6.30 p.m. in Committee Room No. 26. "The Manufacture of Iron and Steel Tubes," by Mr. J. Mitchell. A film will be shown, entitled "A Mobile Crane and Excavator." 7 p.m.

SATURDAY, JANUARY 26TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Gateshead-on-Tyne. General meeting. 2.45 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Southern District meeting to be held at the Town Hall, Oxford. Discussion on "Road Surfaces and a Standard of Maintenance," by Mr. H. V. Overfield ; "Notes on the Construction of a New Public Convenience," by Mr. W. L. Williams. 11.15 a.m.

MONDAY, JANUARY 28TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lecture. "The Treatment of Coal," by Dr. C. H. Lander. Lecture II. 8 p.m.

TUESDAY, JANUARY 29TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Ordinary meeting. Paper to be submitted for further discussion, "The Vibrations of Roads and Structures," by Messrs. James Henry Hyde and Harry Reep Lintern. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS : SCOTTISH CENTRE.—At the North British Station Hotel, Edinburgh. "Some Recent Extensions to Portobello Power Station," by Mr. E. Seddon. The paper will be illustrated by lantern slides. 7 p.m.

INSTITUTION OF ENGINEERING INSPECTION.—At the Rooms of the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. "Errors in Testing Bulk Supply by Random Selection," illustrated by lantern slides, by Mr. B. P. Dudding. 5.30 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "The Influence of Surface Conditions and Internal Stresses on the Physical Properties of Cold-worked and Quenched and Tempered Steels, with Particular Reference to Fatigue Resistance," by Professor F. C. Lea. 7.30 p.m.

WEDNESDAY, JANUARY 30TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, S.W. 1. Students' meeting. "Design and Construction of Victoria House," by Mr. H. George Cousins. 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS : BIRMINGHAM AND DISTRICT ASSOCIATION.—Joint meeting with the Institute of Arbitrators, Incorporated, at Queen's College, Paradise-street, Birmingham. "The Conduct of an Arbitration," by Capt. W. T. Cresswell. 5 p.m.

INSTITUTION OF CIVIL ENGINEERS : MANCHESTER AND DISTRICT ASSOCIATION.—At 36, George-street, Manchester. "The Town Planning Act as Applied to South-East Lancashire," by Mr. A. Morris. 6.45 p.m.

INSTITUTION OF PRODUCTION ENGINEERS : BIRMINGHAM BRANCH.—In the Windsor Room of the Grand Hotel, Colmore-row, Birmingham. "Production in the Foundry, and Has the Foundry Kept Pace with Modern Practice ? " by Mr. D. Wilkinson. 7 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-upon-Tyne. Graduate Section. "Locomotive Power and Proportions," by Mr. Brian Reed. 7.15 p.m.

NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—St. John-street, E.C. 1. "Modern Radio Reproduction," by Mr. P. K. Turner. 5.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "The Shannon Scheme and its Economic Consequences," by Mr. George Fletcher. 8 p.m.

THURSDAY, JANUARY 31ST.

INSTITUTION OF CIVIL ENGINEERS : YORKSHIRE ASSOCIATION.—In the Great Northern Hotel, Leeds. Annual dinner. 7 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. "The Early History of X-rays," by Sir Wm. Bragg, F.R.S. 5.15 p.m.

FRIDAY, FEBRUARY 1ST.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Thomas Hawksley Lecture, "Engineering Principles in the Machinery of the Stars," by Professor A. S. Eddington, F.R.S. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Notes on Road Construction," by Mr. T. H. Cross. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Geometrical Art," by Professor J. L. Myres. 9 p.m.

SATURDAY, FEBRUARY 2ND.

INSTITUTE OF BRITISH FOUNDRYMEN : LANCASHIRE BRANCH.—At the College of Technology, Sackville-street, Manchester. "Works Accounting and Foundry Practice," by Mr. J. O. Gray. 4.30 p.m.

MONDAY, FEBRUARY 4TH.

INSTITUTION OF AUTOMOBILE ENGINEERS : WESTERN CENTRE.—At the Merchant Venturers' Technical College, Unity-street, Bristol. "Coil Ignition," by Dr. F. W. Lanchester. 6.45 p.m.

RAILWAY CLUB.—57, Fetter-lane, London, E.C. 4. Annual general meeting, followed by presidential address. 7.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lecture. "The Treatment of Coal," by Dr. C. H. Lander. Lecture III. 8 p.m.

TUESDAY, FEBRUARY 5TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles," by Mr. H. Kerr Thomas. 7.45 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS : COVENTRY GRADUATES.—At the Broadgate Café, Coventry. "Free Wheels," by Mr. R. A. Clapham. 7.15 p.m.

WEDNESDAY, FEBRUARY 6TH.

INSTITUTION OF CIVIL ENGINEERS : MANCHESTER AND DISTRICT ASSOCIATION.—Midland Hotel, Manchester. Annual dinner of the Association. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Trueman Wood Lecture. "The Vibrations of Railway Bridges : An Example of Co-operative Research," by Sir J. A. Ewing. 8 p.m.

FRIDAY, FEBRUARY 8TH.

CHEMICAL ENGINEERING GROUP.—In the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "The *Rôle* of Surface Energy in Chemical Engineering," by Professor W. E. Gibbs. 8 p.m.

INSTITUTE OF METALS : BIRMINGHAM LOCAL SECTION.—Joint meeting with the Birmingham Metallurgical Society and the Staffordshire Iron and Steel Institute, in the Engineers' Club, Waterloo-street, Birmingham. "Electro-deposition," by Mr. D. J. Macnaughtan. 7 p.m.

INSTITUTE OF METALS : SHEFFIELD LOCAL SECTION.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Some Recent Developments in Nickel Metallurgy," by Mr. W. T. Griffiths. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the Queen's Hotel, Coventry. Annual dinner of the Coventry Graduates.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Informal meeting. "The Profession of the Mechanical Engineer," special discussion introduced by Mr. L. A. Legros. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, Westminster, S.W. 1. "Recent Developments in the Art of Oil Cracking," by Dr. A. E. Dunston. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Recent Problems of Rail Transport," by Mr. C. E. R. Sherrington. 9 p.m.

SATURDAY, FEBRUARY 9TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Annual dinner of the London Graduates at Les Gobelins Restaurant, Heddon-street, Regent-street, W. 1. 7 p.m.

MONDAY, FEBRUARY 11TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the Queen's Hotel, Birmingham. "Coil Ignition," by Dr. F. W. Lanchester. 7 p.m.

TUESDAY, FEBRUARY 12TH.

INSTITUTE OF BRITISH FOUNDRYMEN : LANCASHIRE BRANCH, BURNLEY SECTION.—Lecture Room of the Municipal College, Burnley. "Some Aspects of Modern Foundry Practice," by Mr. Griffiths. 7.15 p.m.

INSTITUTE OF METALS : NORTH-EAST COAST LOCAL SECTION.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "Metallurgy of Engineering," by Mr. J. E. Newson. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—General meeting at the Rover Sports Club, Albany-road, Coventry. "Coil Ignition," by Dr. F. W. Lanchester. 7.30 p.m.

WEDNESDAY, FEBRUARY 13TH.

ILLUMINATING ENGINEERING SOCIETY.—Trocadero Restaurant, Piccadilly, London, W. 1. Twentieth anniversary dinner, 7.30 p.m.

INSTITUTE OF METALS : SWANSEA LOCAL SECTION.—In the Thomas' Café, High-street, Swansea. "Recent Developments in Rolling Metal Strip and Sheet," by Mr. J. E. Malam. 7 p.m.

THURSDAY, FEBRUARY 14TH.

INSTITUTE OF METALS : LONDON LOCAL SECTION.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. "Some Present-day Metallurgical 'Tools' and Methods ; " "The X-ray Spectrometer," by Dr. C. J. Smithells ; "Quantitative Spectroscope Analysis," by Mr. S. V. Williams ; "High Magnification Microscopy," by Mr. H. Wrighton ; "Dilatometers," by Mr. W. E. Prytherch ; "Preparation of Some Unusual Metallographic Specimens," by Mr. A. J. Murphy. 7.30 p.m.